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Ministry of Supply

CHEMICAL RESEARCH & DEVELOPMENT DEPARTMENT

REPORT No. 105.R.47

Mechanically Nitrated Board, Wood Cellulose, for Cordites. Australian Trials, Period March - June 1947.

by

E. Brown

Waltham Abbey
Essex

October
1947

I.G. No. 804.150

Report No. R137-48

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Source Chemical Research & Development Division, C.S.A.R. Eval A-1.
Report No. 105.R.47. Ministry of Supply.

Area Reported On Gt. Britain. Subject ... WOOD CELLULOSE BOARD IN ...

Reference (DIRECTIVE, CORRESPONDENCE, PREVIOUS REPORT, ETC., IF APPLICABLE.)

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SUMMARY: ENTER CAREFUL SUMMARY OF REPORT, CONTAINING SUBSTANCE SUCCINCTLY STATED. ANSWER QUESTIONS WHERE, WHEN, WHAT, HOW, HOW MANY, AND GIVE DATE OF EVENT. IN A FINAL ONE SENTENCE PARAGRAPH GIVE SIGNIFICANCE. BEGIN TEXT ON PAGE 2.

Nitrocellulose was made from Wood Cellulose Board (W.C) by mechanical nitration. The Boards were bleached and made from kraft pulp of the "Pinus radiata" (alpha cellulose content 85%) on a board machine. The boards were shredded and nitrated, one lot to 12.2% N content, another to 13.1% N content. The two lots of NC were divided into lots to check the effectiveness of the American stabilization method and the British 4-boil method. The 4 lots of NC were made into lots of mixed base powder types ..., ..., ... and SC. No difficulties were encountered making these propellants.

COMMENT:

This work was discussed with Dr. A. Lovecy by Dr. Spurlin, Hercules Powder Company, on his visit to the U.K. in connection with Ordnance Research activities. One copy of the inclosure is for direct transmittal to ORDTX and one for Picatinny Arsenal.

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John L. Atkins
JOHN L. ATKINS,
Lt. Col. Ordnance,
Tech. Liaison Officer.

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MINISTRY OF SUPPLY

CHEMICAL RESEARCH DEVELOPMENT DEPARTMENT

C.R.D.D. Report No. 105/R/47

MECHANICALLY NITRATED BOARD, WOOD CELLULOSE, FOR CORDITES. AUSTRALIAN TRIALS, PERIOD MARCH-JUNE, 1947

by

E. BROWN

This report contains information of overseas origin.

Submitted by: F.G.Willson,
Superintendent Propellants
Research (1)

Approved by: H.J.Poole,
Chief Superintendent,
Chemical Research
Development Department.

M.282/47

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C.R.D.D./X(2)956/10/1/2
O.B.Proc.No.33931
L.E./18 (A.M.R.)
Australian Projects E.C.1417 and 1419

SUMMARY

1. Objects of Investigation:

(a) To prepare nitrocelluloses types A and B, suitable for use in British cordites by "mechanical" nitration of 85 per cent. alpha-cellulose pulp of Paper, Wood Cellulose (PWC) grade made from "Pinus radiata."

(b) To convert the nitrocellulose into a representative series of British cordites.

(c) To determine the chemical and ballistic stability of cordites so produced.

2. Scope of Investigations:

A U.K. mission, consisting of Mr. R.V.Eaton, D.S.R.N.P.F., Mr. C.S.Livingston, S.R.O.F., Bridgwater, Mr. E.Brown, P.S.O., C.R.D.D., Dr. A. Lovecy, P.S.O., C.R.D.D., visited Australia in the period March to June 1947, to observe the early part of the trials and to advise on their conduct. Mr. E. Brown attended the trials from April 2nd to June 27th 1947 inclusive and was particularly concerned with the conversion of the nitrocelluloses into cordites and with the drafting of detailed programmes for the storage trials of the gun-cordites.

A supply of Board, Wood Cellulose, (BWC) had been prepared in February 1947 by Australian Paper Manufacturers Limited at their Melbourne and Maryvale mills in Victoria, Australia from 85 per cent. alpha-cellulose pulp of PWC grade derived from "Pinus radiata". This consignment of board was harder than had been specified, but it was necessary to conduct trials with this material in order to avoid the delay inevitable if fresh board were awaited.

Nitrocelluloses of nominal nitrogen contents of 12.2 and 13.1 per cent. were prepared from the board in the mechanical nitration plant at the Australian Government Explosives Factory at Mulwala, N.S.W. during March, April and May 1947. Two boiling-schemes for stabilisation of the nitrocelluloses were investigated: one was based on the system used for nitrocelluloses for American smokeless powders and the other on the British 4-boil system, in order to compare the relative stabilising efficacies of the two procedures and hence arrive at the most economical scheme of stabilisation in respect of fuel and water consumption.

Exploratory trials to determine the suitability of the nitrocelluloses for cordite manufacture were carried out by making them into small lots of Cordites N, NQ, NFQ, MNF and SC on the full-scale cordite plant at the Explosives Factory, Maribyrnong, Victoria, in April, May and June 1947.

The programme of storage trials given in O.B.Proc. No.33931 for the gun-cordites was discussed at meetings of representatives of the Australian departments concerned and it was agreed to lengthen the period and modify somewhat the conditions of storage. Arrangements for storage, laboratory testing and firing of the gun-cordites were made, and a detailed programme drafted for each item.

3. Conclusions:

As foreseen when the programme of trials was drafted, 85 per cent. alpha-cellulose pulp from "Pinus radiata" is liable to give a hard board from which it is difficult to produce shreds which are easily nitrated and stabilised. It will probably be possible to make a board softer than that with which the trials have so far been conducted.

Solvent and semi-solvent picrite-based cordites were made without difficulty from the board supplied. Cordite S.C. showed a tendency to speckiness, particularly in the case of nitrocellulose stabilised by U.K. schemes of boiling, but the speckiness could be reduced by about 25 per cent. additional hot rolling of the sheet. The cordite so obtained was suitable for use in guns; cordite of a physical quality judged suitable for use in rockets was approached, but not quite reached.

4. Further work:

The trials in Australia are continuing. A second supply of Board, Wood Cellulose, has been obtained which is softer than the first consignment, although its bursting strength is still undesirably high. Mechanical nitration to a nitrogen content of 12.2 per cent. with three types of stabilisation, is in hand in comparison with High-alpha-cellulose Board and shredded PWC. The nitrocelluloses will be tested by manufacture into Cordite S.C. On the basis of this trial it is hoped to devise a practical and economical scheme of nitration and stabilisation of BWC for use in the preparation of the cordite for the storage trials.

REPORT

1. Introduction

The annual production of Australian-grown by-product cotton is inadequate to meet the cellulose requirements of Australia's wartime propellant manufacture, and, in consequence, to achieve independence of overseas supplies. The use of wood cellulose has been developed in Australia to such an extent that it has been possible to meet the demands of the Australian Services for all gun-cordites and 75 per cent. of small arms cordites from the Australian-grown timber "Pinus Radiata". (The manufacture of cordites for rockets has not yet been attempted in Australia.) Present practice is to use the wood cellulose in paper form as demanded by Specification DCTM 934 J (which is based on A.165 I), and this material (Paper, Wood Cellulose - PWC) has been successfully used for the production of cordites Mk.I, MDT, W, WM, SC, HSC, NFQ, N and NQ.

These cordites have all been prepared from nitrocellulose of either 12.2 per cent. or 12.9 per cent. nitrogen, made by the displacement process in the Australian Government Explosives Factories at Maribyrnong and Ballarat in Victoria. The Ballarat Factory has now been dismantled and the only displacement nitration plant remaining in Australia is at Maribyrnong. This plant is much too small to meet wartime requirements. There is, however, a Government Explosives Factory at Mulwala in New South Wales which was erected during World War II for the manufacture of the American single-base propellants NH, FNH and IMR. This factory has a capacity of about 6000 tons per year of nitrocellulose, which is ample for Australian requirements, but the nitrocellulose is prepared by the "mechanical" nitration process.

The American propellants for which the Mulwala Factory was built require the use of "High-Alpha-cellulose" wood pulp. This contains 92-93 per cent. alpha-cellulose and is prepared by applying a cold alkali refining treatment to pulp of PWC grade (85-86 per cent. alpha-cellulose). Very considerable economies would be effected if the alkali refining process could be dispensed with, and the use of PWC grade itself in the mechanical nitration plant at Mulwala would be very attractive.

The Australian Department of Munitions consequently proposed that consideration should be given to the use in British cordites of mechanically nitrated wood pulp of PWC grade derived from "Pinus Radiata". If this were acceptable, it would be possible for Australia to take advantage of the nitrocellulose manufacturing capacity of the Mulwala factory for all nitrocellulose requirements.

The proposal gave rise to the following technical problems:-

1. Whether Nitrocellulose Types A and B made from wood cellulose by the mechanical nitration process will be acceptable for all natures of cordite in Service.

2. Whether PWC grade pulp without alkali refining is suitable for the shredding and mechanical nitration operations.

As regards 1, the information available from American and German practice, together with the research work already carried out in the C.R.D.D. to correlate nitrocellulose characteristics with cordite properties, suggested that the adoption of mechanical nitration, per se, was not likely to introduce serious difficulties.

As regards 2, PWC pulp has a rather higher content of "cementing ingredients" than have High-alpha-cellulose pulps, from which such ingredients are largely extracted in the refining process. Hence it was possible that with pulp of PWC grade, boards might be less readily obtained with the physical properties necessary for satisfactory shredding and uniform nitration (Reference 1).

At a meeting of representatives of the Australian Munitions Department and interested U.K. Departments at the Ordnance Board Offices on 29.8.46, a programme of trials was approved covering the mechanical nitration of 85 per cent. alpha-cellulose pulp derived from "Pinus radiata", conversion of the nitrocelluloses into various cordites and storage trials of the cordites. The programme is given in O.B.Proc. No.33931, and the relevant portions are summarised in Appendix 1. The production trials of the nitrocelluloses and cordites were scheduled to be carried out in Australia, and the storage trials in both U.K. and Australia where practicable.

It was decided that representatives of the U.K. and Canadian Government should be present at the production trials in Australia, and a U.K. mission visited Australia during the period March to June 1947 to observe the early part of the trials and to advise on their conduct.

The mission consisted of:

Mr. R.V.Eaton	D.S.R.N.P.F.
Mr. C.S.Livingston	S.R.O.F. Bridgwater.
Mr. E.Brown	P.S.O., C.R.D.D.
Dr. A.L.Lovecy	P.S.O., C.R.D.D.

The trials were carried out at the Australian Government Explosives Factories at Maribyrnong, Victoria and Mulwala, N.S.W. under the general direction of the Explosives Committee of the Australian Department of Munitions. Mr. E. Brown attended the trials from April 2nd to June 27th 1947 inclusive and was mainly concerned with the conversion of the nitrocelluloses into cordite and with the drafting of the detailed programmes for the storage trials of the gun-cordite items. The present report deals chiefly with these two matters, and also includes data on the pulp, the board and the nitrocelluloses used in the manufacturing trials of the cordites.

2. Objects of the trial

(a) To prepare nitrocelluloses, Types A and B suitable for use in British cordites by the mechanical nitration of 85 per cent. alpha-cellulose pulp of PWC grade made from "Pinus radiata".

(b) To convert the nitrocelluloses into a representative series of British cordites for guns, small arms and rockets.

(c) To determine the chemical and ballistic stability of cordites so produced.

3. Methods employed

Pulp 12 tons of Pinus radiata kraft pulp were available from a 15-ton lot which had been prepared and bleached according to PWC procedure at the Maryvale mill of Australian Paper Manufacturers Ltd. during September 1946. The manufacturing data on the pulp are given in Appendix 2.

Board This supply of pulp was converted into approximately 10 tons of Board, Wood Cellulose (BWC)*, Consignment No.202, on No.1 machine of the Prince's Bridge, Melbourne mill of A.P.M. Ltd. on 24.2.47. The requirements specified for the board were: moisture content to be not greater than 10 per cent., caliper to be in the range 39 to 45 mils and chemical properties to conform to D.C.T.M. Specification 934J, i.e. it was to have physical properties similar to those of High-alpha-cellulose Board, but was to be chemically similar to PWC. Boarding was carried out at a machine speed of 50 ft./min. and at a production rate of 1 ton/hr., pressure being applied in the first and second presses and one nip allowed in the calendar; all clean broke was returned to the beater-room for re-use in the furnish. The board was formed directly on the machine into rolls having a width of 30 inches, with a diameter not exceeding 36 inches (Reference 2). The manufacture was observed by I.N.O.

Nitrocellulose During March 1947 about 3000 lb. of BWC Consignment No.202 were mechanically nitrated to a nominal nitrogen content of 12.2 per cent., and about 5500 lb. to a nominal nitrogen content of 13.1 per cent. In order to avoid a dense shred, it was found necessary to run the shredder at its lowest feed-rate, which reduced the output of the shredder to about half normal. The dried, shredded pulp for nitration contained about 0.8 per cent. moisture. A nitration-time of 1 hour, double that used for High-alpha cellulose, was adopted in order to guard against excessive amounts of "acetone-insoluble" in the product.

Two methods of stabilisation were investigated: one was based on the American system used at the Explosives Factory, Mulwala, for the preparation of the nitrocellulose required in the manufacture of Dupont's single-base powders NH, FNH and DMR; the other was based on the British 4-boil system as laid down in Specification CS.1154.

For stabilisation, the nitrocelluloses of 12.2 and 13.1 per cent. nitrogen obtained from the shred were each divided into two halves, with precautions to ensure, as far as possible, that the two halves for each variant were identical.

One half of the 12.2 per cent. N nitrocellulose was stabilised by a scheme similar to that used for American "Pyro" nitrocellulose, viz. 40 hours boil in liquor of acidity maintained within the limits 0.25 to 0.5 per cent. reckoned as H_2SO_4, 5 hours boil in fresh ordinary process water, 5 hours boil in fresh ordinary process water, the boilings being carried out at a temperature above 95°C. in an unlined wooden vat fitted with a central kier-pipe and a recording thermometer. The vat was filled to the normal depth with water, but as the nitrocellulose load was 2000 lb. compared with the normal load of 7500 lb. (with 87,500 lb. water), stabilisation took place at a considerably lower nitrocellulose concentration than normal. The nitrocellulose was then pumped through two Jordan refiners in series, at a concentration of approximately 0.9 lb. per gallon,

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* It was decided by the Australian Explosives Committee (Reference 3) to apply the name "Board, Wood Cellulose" and the letters "BWC" to designate board made from 85% alpha-cellulose pulp of PWC grade derived from "Pinus radiata". The name "High-alpha-cellulose Board" and the letters "ACB" are applied to board made from 92-93 per cent. alpha-cellulose pulp of a grade suitable for American smokeless powders and derived from "Pinus radiata". The name "Paper Wood Cellulose" and the letters "PWC" are used to denote paper made from 85 per cent. alpha-cellulose pulp to Specification DCTM 934 J.

and reduced to a satisfactory fineness. Subsequent treatment given was "poaching" by the following series of boilings in wooden vats with cone-stirrers:

One boil of 4 hrs. with 0.02 per cent. Na_2CO_3 solution
One boil of 2 hrs. with fresh water
Two boils of 1 hr. each with fresh water,

and finishing by passing on to the Packer screen, blanket run and vacuum filter, and centrifuging to a moisture content of about 42 per cent. This lot of nitrocellulose was designated "SP7".

The other half of the 12.2 per cent. N nitrocellulose was stabilised by a scheme designed to approximate as closely to the British 4-boil system laid down in Specification CS 1154 as could be managed with the American type of plant at the Explosives Factory, Mulwala. The boilings were: 12 hours in water with an initial acidity less than 0.1 per cent. calculated as H_2SO_4, 12 hours in ordinary process water without the addition of acid or alkali, 4 hours in water with additions of soda ash totalling 44 lb., 4 hours in water with additions of soda ash totalling 30 lb. An unlined wooden vat fitted with a central kier-pipe and a recording thermometer was used, and the temperature was maintained above 97°C. The load of nitrocellulose was again 2000 lb. and the vat was filled to its normal depth with water. Pulping had to be carried out by one pass at a concentration of 0.9 lb./gallon through two Jordan refiners in series and one pass through a single Jordan refiner, instead of using a Hollander beater. This lot of nitrocellulose was finished by washing twice by decantation with ordinary process water in a wooden tub, passing through the Packer screen, over the blanket run and vacuum filter, and centrifuging to a moisture content of about 42 per cent. It was designated "SP8".

The two halves of the 13.1 per cent. N nitrocellulose were treated similarly, except that (a) the vat-load was 3800 lb. nitrocellulose,
(b) the length of the initial boil in the American scheme of stabilisation was 60 hours, as is adopted for American "Higrade" nitrocellulose,
(c) two additional 4-hour boils with sodium carbonate solution were necessary after finishing in the case of the British scheme of stabilisation in order to achieve satisfactory stability as indicated by the B. & J. test. The 13.1 per cent. N nitrocellulose stabilised by the American scheme was designated "G3" and that stabilised by the British scheme "G4".

Nitration and stabilisation of lots SP7, SP8, G3 and G4 were carried out in the plant in the Nitration Area of the Explosives Factory, Mulwala, and were observed by Messrs. Eaton and Livingston and Dr. Lovecy. The plant used was that installed for the preparation of nitrocellulose for Dupont's Smokeless Powders NH, FNH and IMR, and is described in C.R.D.D. Report No.106/R/47 (Reference 4). Two Progress Reports and a commentary on the manufacture of the four lots, by Dr. Lovecy, are given in Appendix 3, which contains also the manufacturing data for the four lots.

In April and May 1947, an attempt was made at Mulwala to repeat the British-type scheme of stabilisation of 12.2 per cent. N nitrocellulose from BTC Consignment No.202 with the full load of 7500 lb. nitrocellulose in the vat. For this trial the current Australian practice for British-type nitrocellulose was adopted of adding chalk instead of soda ash to obtain the specified alkalinity of 27 parts $CaCO_3$ per 100,000 parts of

liquor for the two 4-hour boils. This lot of nitrocellulose was designated "SP9". Manufacturing data are given in Appendix 3. The result of the B. and J. test at the end of the 4th boil was 1.6 mgm. nitrogen/gm. which considerably exceeds the specified limit of 1.0 mgm./gm. At the end of the 4th boil the 7500 lb. was therefore divided into portions, which were given respectively the following supplementary treatments:

Lot SP9/3A Boiled for 4 hours at a temperature above 97°C in a wooden vat fitted with a central kier-pipe in Yan Yean water, the alkalinity of which had been brought up to the equivalent of 27 parts $CaCO_3$ per 100,000 by the addition of soda ash, pulped for 5 hours in a Hollander beater and given two poachings and normal finishing treatment.
Carried out at Explosives Factory, Maribyrnong.
Dry weight: 644 lb.

Lot SP9/3B Given two 4-hour alkaline (soda ash) boils as for lot SP9/3A, pulped for 3 hours in a Hollander beater and given two poachings and normal finishing treatment.
Carried out at Explosives Factory, Maribyrnong.
Dry weight: 496 lb.

Lot SP9/2 Pulped in the Jordan refiners to a satisfactory fineness and given three 4-hour boils, the liquor being brought to the specified alkalinity by the addition of calcium carbonate. Washed by decantation in the poacher tub, grit-run, Packer-screened, vacuum-filtered and centrifuged.
Carried out at Explosives Factory, Mulwala.

Lot SP9/1 Pulped in the Jordan refiners to a satisfactory fineness and given two 4-hour boils, the liquor being brought to the specified alkalinity by the addition of soda ash. Washed by decantation in the poacher tub, grit-run, Packer-screened, vacuum-filtered and centrifuged.
Carried out at Explosives Factory, Mulwala.

The preparation of the SP9 series of nitrocelluloses was not observed by the Mission.

Cordites The nitrocelluloses were transferred by road in air-tight containers from the Explosives Factory, Mulwala to the Explosives Factory, Maribyrnong, a distance of approximately 160 miles. On receipt, each lot (with the exception of lots SP9/3A and SP9/3B) was blended, during the course of which it was passed through a Nitrocellulose Breaker twice to open up any undesirable agglomerates.

Exploratory trials to determine the suitability of the nitrocelluloses for cordite manufacture were carried out by making them into small lots of selected cordites on the full-scale plant at the Explosives Factory, Maribyrnong.

Nitrocellulose G3 was made into	Cordite N/S 164-048	Mix 6E
	Cordite NQ/S 134-040	Mix 7E
" G4 " " "	Cordite N/S 164-048	Mix 8E
	Cordite NQ/S 134-040	Mix 9E
" SP7 " " "	Cordite SC 109	Mixes 2E & 3E

Nitrocellulose	SP8	was	made	into	(Cordite SC 109 (Cordite NFQ/S 168-048 (Cordite MNF 150	Mixes 1E & 4E Mix 5E Mix 5E
"	SP9/3A	"	"	"	Cordite SC 109	Mix 10E
"	SP9/3B	"	"	"	Cordite SC 109	Mix 11E
"	SP9/2	"	"	"	Cordite SC 109	Mix 12E

Mixing of nitrocellulose and nitroglycerine for all the cordites, and, in the case of Cordite S.C., for the addition of carbamite, was done by the "Wet Mix" process. The wet-mix plant at Maribyrnong is of the "Ring-main and Tundish" type and closely follows the plant used during World War II at R.N.C.F. Holton Heath; one point of difference is that the wet-mix tank is octagonal instead of circular in cross-section and is not fitted with baffles. Since the quantities of nitrocellulose used in the trials were too small to permit of the operation of the ring-main, the required quantities of nitrocellulose were weighed into the filtration tank and stirred with the normal proportion of water for half-an-hour to produce a well-dispersed suspension. Wet-mixing was done at 32°C. Truck-drying of paste-sheet was carried out for the normal time of 27 hours using air at a temperature not above 50°C. For cordites made by a solvent process, the paste-sheet was crumbled before drying by means of a ridged roller attached to the end of the paste-sheeting table.

Incorporation, pressing and stoving of the solvent cordites followed U.K. practice and specifications closely. Welland picrite of a specific surface of 10,000 to 12,000 sq.cms./cc. was used for cordite NFQ as well as for Cordites N and NQ. The solvent for cordites N and NQ was 20 per cent. of 92/8 acetone/water. The press-cylinders were loaded with the aid of a lever-stemmer. Six dies per plate were used and the cordite was collected by being run up a table and cut with a rotary knife of the Caerwent type.

The semi-solvent cordite MNF 150 was made with 10,000 to 12,000 grade picrite to the same composition as Cordite NFQ but with the inclusion of 0.075 per cent. Candelilla Wax, which was added at the incorporation stage. The dough from the incorporator was cold-rolled six times with a roll-gap of 0.15-inches, and the sheet so produced truck-dried for 3½ hours with air at 50°C. and matured for about a day, the residual V.M. content of the sheet then being 3.5 per cent. Hot-rolling consisted of 15 bookfold passes with a roll-gap of 0.08 inch and a roll-temperature in the range 32°C. to 36°C. Pressing was carried out using normal Cordite S.C. plant and Cordite S.C.150 dies. The die was maintained at a temperature of 62°C, and the extrusion-pressure was 600 x 11.69 lb./sq.in.

For Cordite S.C. a normal Greenwood and Batley 20-inch wide rolling mill was used. The standard milling procedure was: scrap, 3 passes; virgin paste, 5 passes; wedded sheets, 3 passes, all at roll-temperatures in the range 44°C. to 48°C. and at a roll-gap of 0.08 inch; the passes were done with the sheet arranged in bookfold form. The milling procedure was varied on occasions as stated in Section 4 below, in attempts to reduce speckiness of the sheets. The surface of the rolls was blemished in places through previous use: after the early trials the rolls were reground and it was in this state that they were used for the experiments with Cordite S.C. made from the nitrocelluloses of the SP9 series.

Square-cutting and blocking followed R.N.C.F. practice. In the early trials the temperature of the cordite blocks was not well controlled, but

for the SP9 trials, jacketted heating tanks combined with blanket-wrappings for the blocks were installed.

Pressing was carried out in a hydraulic press with a cylinder of square cross-section as at R.N.C.F. The die temperature was about 60°C. in the early trials, but was maintained within the range 62°C. to 65°C. for the SP9 trials. Cordite S.C.109 dies were used, and the cord collected on a reel. In the early trials the reeling gear was not correctly adjusted and tended to cause stretching of the cords: this was rectified for the SP9 trials.

It was not practicable to use 12.2 per cent. N nitrocellulose made from PWC by the displacement process as a control in the manufacturing trials of Cordite S.C.,so paste-sheet for Cordite S.C. (lot 47X12) made in March 1947 from such nitrocellulose was adopted as control.

Chalk, as specified, was added during manufacture of the cordites. In one or two instances where the normal amount of chalk had not been added to the nitrocellulose in its finishing stages, adjustment was made during cordite manufacture. Samples of the cordites at various stages were taken by the Australian Navy and Army Inspection Departments for examination. Manufacture of the cordites was observed by Messrs. Brown, Livingston and Eaton.

Storage Trials The manufacturing trials carried out during the period under review were exploratory, and the cordites made in them will not be used for the storage trials specified in the programme laid down in O.B. Proc. No.33931. Small quantities of these preliminary cordites are however to be selected and subjected to climatic storage trials with observation of chemical and physical properties.

Manufacture of the bulk quantities of cordites for the O.B.Proc. No.33931 storage trials will await the development of methods of manufacturing nitrocellulose which is satisfactory as regards chemical stability and suitability for processing into cordite for rockets. The scheme of stabilisation to be adopted for the nitrocellulose was not specified in the programme and remains to be determined by trials which are still in progress: the scheme adopted will not necessarily be the British or American scheme mentioned above but will be the shortest consistent with both acceptable stability and economy in fuel and water. If it should be found necessary to adopt different schemes of stabilisation for the Australian and for the U.K. types of stabilisation plant, it is at present intended that the programme should be carried through completely with nitrocellulose stabilised by a method suitable for Australian plant, and that the portions of the programme dealing with Cordites SU, SC, NFQ and N should be duplicated with nitrocellulose stabilised by a method suited to British plant.

The storage trials for gun cordites outlined in the programme in O.B.Proc.No.33931 had been criticised by S.P.R.I. of C.R.D.D. on the grounds that

(i) a duration of one year would only clear the cordites for a Service life of 6 years at 90°F.,and

(ii) storage of the picrite-based cordites under damp conditions was not included.

The matter was discussed at a meeting of representatives of D.C.R.D., D.A.S., D.O.F.(X), C.R.D.D. with A.M.R. at Shell Mex House, London, England on 27.2.47., at which it was agreed that it would be preferable that storage should be for 0, 6, 12, 24, 36 and 48 months instead of for 0, 3, 6, 9 and 12 months, and that storage at 100°F. (dry, continuous) should be replaced by storage under I.S.A.(A) conditions if suitable facilities could be provided in Australia. It was arranged that Mr. E. Brown should discuss these points with the Australian authorities, and meetings for the purpose were held at Maribyrnong on 15.4.47, 2.5.47 and 24.6.47 (References 5, 6, 7) at which the Australian Explosives Committee, the Explosives Factory, Maribyrnong, the Munitions Supply Laboratories and the Australian Navy and Army Inspection Departments were represented. The extension of the storage period to clear the full Service lives of the cordites was thought by the Australian authorities to be most desirable: arrangements were made for the provision of storage facilities, including those for I.S.A.(A) trials of the picrite-based cordites. In anticipation of a decision on the type of stabilisation to be applied to the nitrocellulose, a detailed programme of storage, laboratory testing and firing was drawn up for each gun-cordite item and was approved at the meeting on 24.6.47. A summary and a copy of each programme are given in Appendix 4. The modifications to the length and conditions of storage of the trials will require approval by the Ordnance Board of the U.K.

The range at Port Wakefield was visited by Messrs. Brown and Livingston. A larger heating chamber is to be installed and it was considered that the range would then be suitable for the gun-firings in the O.B.Proc. No.33931 programme.

4. Results

Board The results of measurements made by the Munitions Supply Laboratories on BWC Consignment No.202 as received are given in Appendix 5. This supply of BWC was fairly satisfactory for caliper, but it was rather variable in bursting strength. Moreover, its mean bursting strength was about three times that of board made from High-alpha-cellulose pulp and its mean density about 25 per cent. greater; it was considerably stronger and somewhat denser than board obtained from PWC grade pulp in a pilot manufacture which had been carried out a few months previously on a 1-ton scale. Australian Paper Manufacturers Ltd. were of the opinion that it might be possible to obtain a board of lower density by making adjustments on the board machine.

It was realised from the outset that this board was undesirably hard and that even with the reduced rate of shredding adopted it would give an appreciable amount of dense "stringy" shred. However it was decided to continue trials with this material to avoid the delay inevitable if fresh board were awaited.

Nitrocellulose The results of measurements by the Explosives Factories at Mulwala on the nitrocelluloses made from BWC Consignment No. 202 are given in Appendix 6. It is seen that it was not possible to obtain stable nitrocellulose, as judged by the B. and J. Test, from this supply of board consistently if the boiling scheme was restricted to one approximating to the 4-boil scheme used in the U.K., although material satisfactory as regards stability was obtainable with 6 boils or with the U.S. system of boils.

Cordite

Solvent Cordites The manufacture of the solvent cordites N and NQ from nitrocellulose lots G3 and G4 proceeded normally. The product was normal in appearance and the weights per 100 inches were the same as when nitrocellulose made by the displacement process from PWC and the same dies are used. No difference was noticeable between the behaviours of G3 and G4.

The manufacture of Cordite NFQ 164-048 from nitrocellulose SP8 proceeded normally. The product was satisfactory, with a weight per 100 inches of 630 grains, which is comparable with current production at Maribyrnong, allowing for there being no wet waste at the incorporation stage.

Semi-solvent cordite Cordite MNF 150 Mix 5E from nitrocellulose lot SP8 was the first semi-solvent cordite made at Maribyrnong. No difficulties in manufacture were experienced, and the sheets hot-rolled readily in spite of the fact that the picrite used was coarser than that adopted at R.N.P.F., Caerwent. The dried sticks were satisfactory having the highly polished surface characteristics of the semi-solvent product.

Cordite S.C. Cordite S.C. Mixes 2E and 3E made from nitrocellulose lot SP7 (American-type boil) and mixes 1E and 4E made from nitrocellulose SP8 (U.K.-type boil) behaved normally during wet-mixing. The paste sheets were slightly more cracked on the surface and at the edges than normal but not sufficiently to cause any trouble in handling; the paste-sheets also showed slightly more semi-gelatinised specks than normal, these being somewhat more frequent in the sheets from SP8.

Hot-milling of the cordite from SP7 with 3 + 5 + 3 passes gave a gelatinised sheet which was slightly specky compared with U.K. experience, although not more so than sheet obtained normally at Maribyrnong from displacement-nitrated PWC. The sheet was considerably aerated owing to the poor surface of the rolls. On pressing this sheet, all specks except an occasional one disappeared, and the cord was relatively free from specks although it had a slightly rough surface: normal Cordite S.C. pressed at the same time was very similar. The general quality was judged as acceptable for gun-cordite, but, mainly owing to aeration, not good enough for rockets.

3 + 5 + 3 passes with the cordite from SP8 yielded a specky sheet, which on pressing gave a specky cord with a rough surface. Giving two extra passes through the rolls to the virgin sheet, making a total of 3 + 7 + 3 passes, considerably reduced the speckiness of the gelatinised sheet, although it still contained a large number of specks about $\frac{1}{8}$-inch in diameter. On pressing, this material gave a cord of normal Australian quality, i.e. suitable for gun-cordites but not good enough for rocket cordite.

The weights per 100 inches for these cordites approached the normal value for Cordite S.C.109 from the same dies, but they are not reproduced in this report since it is known that the reeling gear was not working correctly during their manufacture.

The specks in the gelatinised sheet were examined chemically and confirmed to be mainly ungelatinised nitrocellulose. The stages of the processing were checked by visual examination and by comparative trials with paste made from normal PWC, and it was established that the additional

speckiness obtained from nitrocellulose lot SP8 was not due to errors in processing.

Possible explanations of the greater speckiness with SP8 than with SP7 were that:

(i) the long boil of the American type tends to give nitrocellulose with a wider range of nitrogen contents, which is thought likely to promote ease of gelatinisation.

or (ii) Hollander beating is more suitable for short-boiled nitrocellulose than Jordan refining.

Microscopic examination of nitrocelluloses SP7 and SP8 did not reveal any marked difference between the two, apart from a possibly slightly greater coarseness and clustering with SP8.

An attempt to compare the effect of the Hollander beater and the Jordan refiner was made in the full vat-scale stabilisation by the U.K. type scheme in the SP9 series of nitrocelluloses.

The nitrocellulose variants lots SP9/3A, SP9/3B and SP9/2 were made into cordite S.C.109, using, as a control on the milling operations, Paste Mix No.47X12 which had been made in March 1947 from nitrocellulose lot Test 672 (made from PWC by the displacement process; a blend of 4-boil and 7-boil, with a settling test value of 78). The three variants wet-mixed easily, SP9/2 being slightly more "porridgy" after the addition of carbamite. Behaviour on the paste-sheeting table was excellent, the sheets cohered well and were free from large specks of semi-gelatinised material. The sheeting table had been repaired during the previous week, and, during the first sheeting of the Cordite S.C. from SP9/3A, there were several stoppages for adjustment of the new cloth and the vacuum system; this caused some of the SP9/3A paste-sheet to be over-compacted on the table and might partly account for the excessive speckiness subsequently encountered with this variant.

The normal milling procedure of 3 + 5 + 3 passes between hot rolls gave an almost clear gelatinised sheet with the control material, but gave excessively specky sheets with the three experimental variants and the cord pressed from them was also specky and of poor surface. With three additional passes of the wedded sheet, making 3 + 5 + 6 passes in all, variants SP9/3B and SP9/2 (Mixes 11E and 12E respectively) gave both sheet and cord as good as the control sample; these were judged to be of good gun-cordite quality and approaching rocket-cordite quality. Three further passes through the rolls, making 3 + 5 + 9 passes in all, did not effect any improvement.

Variant SP9/3A (Mix 10E) was very specky throughout and the specks were not reduced to an acceptable degree by prolonged rolling.

The results are given in detail in Appendix 7, along with photographs of typical portions of the gelatinised sheets. There seems to be an indication that the tendency to speckiness was reduced by additional boiling during stabilisation (cf. Mix 10E - 5 boils - very specky; Mix 11E - 6 boils - much less specky; Mix 12E - 7 boils - slightly less specky than 11E). Comparison of Mixes 11E and 12E seems to indicate that Hollander beating and Jordan refining were similar in their effects regarding speckiness allowing for the fact that Mix 12E had one more boil than Mix 11E.

Rolls with reground surfaces were used in the milling trials of the SP9 series. Aeration of the sheet was very much less than occurred in the SP7 and 8 series before the rolls were reground. The surface of the rolls appeared to require further polishing and when this has been done abnormal aeration of the cordite should not occur. The aeration present in the sheets appears as whitish smudges on the photographs.

The detailed results of chemical and physical examination of the cordite made in the trials were not available when the author left Australia.

5. Conclusions

As foreseen when the programme of trials was drafted, 85 per cent. alpha-cellulose pulp from Pinus radiata is likely to give a hard board from which it is difficult to produce shreds which are nitrated and stabilised as easily as when in the form of paper. Solvent and semi-solvent picrite-based cordites were made without difficulty from nitrocelluloses prepared from the consignment of hard board supplied, but cordite S.C. showed a great tendency to speckiness with the nitrocellulose boiled by the U.K. scheme. By three passes more than normal through the rolls the speckiness could be reduced so that Cordite S.C. judged suitable for use in guns could be obtained; a physical quality suitable for use in rockets was approached but not quite achieved.

It will probably be possible to make a softer board by adjusting conditions on the board-making machine and such a board might give less difficulty in shredding, nitration and stabilisation than the hard board, Consignment No.202, with which the trials so far have been carried out.

The speckiness obtained in Cordite S.C. may have been indirectly connected with the hardness of the board used or may be due to an intrinsic property of nitrocellulose made by shredding and mechanical nitration, e.g. it is probable that mechanical nitration gives nitrocellulose with a smaller range of nitrogen values than the displacement process and this tends to increase the difficulty of gelatinisation during processing into solventless cordite. Some confirmation of the latter hypothesis may be given by the fact that Cordite S.C. made from nitrocellulose derived from the soft High-alpha-cellulose Board by shredding and mechanical nitration has been specky.

6. Further work

Australian Paper Manufacturers Ltd. have attempted to make a softer BWC from 85 per cent. alpha-cellulose derived from Pinus radiata. The product of the trial designated Consignment No.203, has "off-machine" characteristics as follows:

caliper - 32 to 38 mils.
density - 0.40 to 0.54 oz./sq.ft./10 mils.
Mullen bursting strength - 85 to 118 lb./sq.in.
moisture - 2.6 to 10.4 per cent.

About 10 tons of this quality are available. This consignment is an improvement on Consignment No.202, although its bursting strength still exceeds that of High-alpha-cellulose Board.

Information has recently been received privately from Australia that trials have been commenced with this supply of board. High-alpha-cellulose

Board and shredded PWC will be tried in parallel with the BWC in an attempt to elucidate the problems mentioned in the conclusions above. Each cellulose will be mechanically nitrated to 12.2 per cent. N and 1000 lb. of each nitrocellulose will be given respectively the following schemes of stabilisation:

(i) 12 + 12 + PJ + 4 + 4
(ii) 12 (acidity 0.25 to 0.5 per cent.) + 12 + PJ + 4 + 4
(iii) 40 (acidity 0.25 to 0.5 per cent.) + 5 + 5 + PJ + 4 + 2 + 1 + 1

The time of nitration will be 60 mins. for BWC Consignment No.203 and 30 mins. for the High-alpha-cellulose Board and the PWC. The alkalinity of the alkaline boils will be obtained by the use of sodium carbonate. Pulping will be by Jordan refiner and will precede the alkaline boils in view of the indications in the trials so far conducted that these boils are more effective when applied to the nitrocellulose in pulp form. PWC nitrated by displacement and stabilised by the normal U.K. 4-boil scheme at Maribyrnong is to be used as a control. All the nitrocelluloses will be tested by manufacture into Cordite S.C.

7. Acknowledgments

It is a pleasure to acknowledge the interest taken in the trials by Mr. N.K.S.Brodribb C.B.E., F.R.I.C., Australian Controller-general of Munitions and Mr. A.E.Leighton C.M.G., F.R.I.C., M.I. Chem.E.,Australian Government Consultant on Explosives, and to thank Mr. J.L.Knight M.Sc., Secretary, Australian Explosives Committee, the managers and staffs of the Explosives Factories, Maribyrnong and Mulwala, and the Chemical Assistant Superintendent and staff of the Munitions Supply Laboratories for the facilities so cordially and helpfully afforded in connection with the trials.

8. References

Ref.1 O.B.Proc. No.33931, Minute dated 27.8.46 from D.C.R.D. to Sec. O.B.

Ref. 2 A.P.M. Ltd. Research Dept. Report No.65: A8.31 (18.3.47)

Ref.3 Minute 5246, Explosives Committee,Australian Dept. of Munitions, 16.4.47.

Ref. 4 "Visit to Australia, March-June 1947" E.Brown. C.R.D.D. Report No.106/R/47.

Ref. 5 Minutes of Conference on Proof Programmes, Maribyrnong 15.4.47

Ref. 6 " " " " " " " 2.5.47

Ref. 7 " " " " " " " 24.6.47

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List of Appendices

Appendix 1

Programme of trials of gun-cordites
(Extracted from O.B. Proc. No.33931)

Propellants for trial

Item	Nature of Cordite	Form and size	Equipment in which to be tried etc.
5	S.C.	Cord 109	For Q.F. 4.7" Mk.12.
6	NFQ	S/168-048	do.
7	MNF	S/168-048	do.
8	WM	Cord 017)	For trials in Q.F. 25-pr.,
9	WM	Cord 061)	1st and full charge.
10	WM	T/211-100	For Q.F. 25-pr. supercharge.
11	N	S/164-048	For Q.F. 3.7" Mk.1.
12	NQ	Cord 018)	For trials in Q.F. 25-pr.,
13	NQ	Cord 050)	1st and full charge.
14	NQ	S/134-040	For Q.F. 25-pr. supercharge.
16	NQF/P	Cord 128	For B.L. 6" Mk.23.

Storage and testing

Chemical analysis, stability tests and firing trials should be carried out on representative samples of all types and sizes after 0, 3, 6, 9 and 12 months continuous storage at 80°F., 100°F., and 120°F.

Location of trials

Gun and S.A. cordite climatic/firing trials to be carried out in duplicate (i.e. in Australia and U.K.). This also applies to rocket cordites where practicable.

Details of gun trials

Each individual firing should comprise the normal propellant proof routine, but if standard rounds are not available in sufficient quantities, any good lots of normal cordite of proved ballistic stability could be used in lieu provided there would be no break from one lot to another throughout the 12 months trial of each experimental cordite.

The Australian authorities concerned to be advised that, for each experimental cordite, the same barrel should be used at all firings and for no other purpose whatever while the trials are proceeding.

Control samples

The manufacture of normal cordites for use as control samples for the trials was decided against.

Quantities to be manufactured

The Australian authorities concerned to decide what quantities of each type and size to make.

Appendix 2

Pulp used for manufacture of BWC Consignment No.202

Manufacturing Data

Cooking Data (Taken from A.P.M. Maryvale Weekly Statistics, w.e. 28.9.46)

Wood Quality	Type	Pinus radiata
	O.D.Value	47.7%
	Density	25.2 O.D.lb./cu.ft.
Cooking Conditions	Alkali on O.D.Wood	25.4% Na_2O
	Sulphidity	21.6%
	Liquor ratio	4.1 : 1
	Black liquor in total liquor	15.4%
	Cooking pressure	80 lb./sq.in.
	Time to pressure	1 hr. 53 mins.
	Time at pressure	3 hrs. 7 mins.
	Total cooking time.	5 hrs.
Unbleached Pulp Quality	Permanganate Number	14.9
	Viscosity	4.8 secs.

Bleaching Data (Taken from A.P.M. Maryvale Weekly Statistics, w.e.5.10.46).

Bleaching Conditions	Pulp consistency	1.96% O.D.
	Available chlorine	3.8% on O.D. pulp
	Bleaching time	1 hr. 24 mins.
Bleached Pulp Quality	Permanganate Number	4.9
	Viscosity (2% solution)	2.9 secs.
	Ash	0.35% on O.D. pulp

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Appendix 3

PROGRESS REPORT ON PROJECT E.C. 1417

by A.L. Lovecy

March 31st 1947

RAW MATERIAL:

Approx. 10 tons of Paper Wood Cellulose Board were supplied, the following characteristics have been determined:-

Physical	Chemical
Caliper 0.039 - 0.048	Lignin (H_2SO_4 test)
Oz. /sq. ft./0.01" 0.58	- conforms
Mullen burst, lb./sq.in.:-	Ash 0.5
Max. of 12 sheets, dry 160	Ash, insol. 0.1
Min. " " " " 94	Ether-sol. 0.03

SHREDDING

Preliminary shredding-trials indicated that a low feed rate was necessary to avoid a dense shred, and for the trial manufacture the lowest feed-rate was adopted, viz. 31 r.p.m. corresponding to 47 ft./min. : ≡ 1,000 lb. shred/hr./reel. Thus the output from the shredder was about 50% of normal but this was ample for the production required in the trial.

NITRATION

The dried, shredded pulp as nitrated contained about 0.8% moisture. In the "12.2N" manufacture, pot charges were 40 lb. pulp + 1760 lb. acid, as for Pyro; in the "13.1N" manufacture, pot charges were 25 lb. pulp + 1100 lb. acid, i.e. 25% greater than for "High Grade".

Following the results obtained in the preliminary pot nitrations, the nitration-time was increased to 1 hr. for both types of N.C. This step was taken mainly to guard against excessive amounts of acetone-insoluble in the product. The nitrator throughput was therefore about 50% of normal (per pot).

Dipping, nitration, wringing, and drowning operations proceeded smoothly and do not call for special comment. The pulp was not in any way remarkable as regards dustiness or immersion behaviour, although it was appreciably less "bulky" than the normal run of shredded alpha board. No fires occurred throughout the trial. Analysis of the mixed acids used are given in Table I.

In order to provide identical batches for long (U.S.) and short (U.K.) stabilisation schemes (see Project E.C.1419), the charges from the wringers were collected in the drowning tub during each complete cycle (i.e. 6 pots of 12.2, or 8 pots of 13.1) and the drowning tub contents pumped alternately to the two boiling-vats, i.e. after alternate cycles.

BOILING

"Short" The procedure adopted for the U.K. method was as follows:- the acid liquor pumped over with the N.C. was drained off, the vat re-filled with fresh water, drained again and re-filled. With both 12.2 and 13.1 types of N.C., after this treatment the liquor acidity was below 0.1 calculated as H_2SO_4 from a titration to methyl orange. This arbitrary limit was adopted as a likely approximation to the liquor condition in normal U.K. practice. The temperature was then raised to boiling point and maintained for 12 hours; the temperature registered on the recorder was checked against a standardised thermometer, which was also used to confirm that the temperature was above 97°C. throughout the vat. The circulation induced by the central kier-pipe was observed to be vigorous in all cases.

Liquor samples for acidity determinations were taken at 2-hour intervals throughout boiling, but no attempt was made to regulate the acidity once the boil had started. Some small additions of water were made from time to time to compensate for losses by leakage.

After the first boil, the liquor was drained off, the vat re-filled, drained, and re-filled again. The second boil was then carried out, with regular tests of the liquor, but no addition of acid or alkali throughout the boil.

The second boil liquor was drained off, the vat re-filled, and drained again. The calculated requirement of soda ash (30 lb. for approx. 100,000 lb. water), dissolved in water, was then siphoned in while filling up with water, and the third boil then carried out. (In the case of this third boil of the 12.2 N.C., it was noted that the alkalinity was only 19 pts. per 100,000 at the end of 1 hr., and a further 8 lb. of soda ash was added. After a further hour the alkalinity was found to be 23 pts., and an addition of 6 lb. soda ash was made. This procedure was not adopted in any other case, since the specification defines only initial alkalinity of the water to be used.)

The fourth boil was carried out in a similar way to the third.

"Long" The procedure for the U.S. method of boiling was as follows:-

By partial drainage of the acid liquor from the N.C. (as received in the vat from the drowning tub), and adding fresh water to make up, the acidity of the liquor at the commencement of boiling was adjusted to about 0.4% as H_2SO_4, and boiling then maintained, for 40 hours in the case of 12.2, 60 hours in the case of 13.1. During this time, acidity tests were made on the liquor at 2-hour intervals. Whenever the acidity reached 0.5% as H_2SO_4, some liquor was drawn off and replaced by fresh water, thus maintaining the acidity within the specified limits of 0.25 - 0.50% as H_2SO_4. The boiling time of 40 hours is reckoned excluding any periods where the recorder shows less than 95°C. (due to liquor - adjustments).

After the acid boil, the liquor was drained off, the vat re-filled, drained, and re-filled with fresh water in which a 5-hour boil was then carried out. The slightly acid liquor from this boil was then drained, etc. and a further 5-hour boil given. At the conclusion of this boil the liquor was only slightly acid.

It is to be noted that in these trials each vat was filled to the normal depth with water, but the quantity of N.C. was much less than usual, being about 2,000 lb. for each of the 12.2 batches and 3,800 lb. for each 13.1 batch,

as against 7,000 lb. N.C. plus 87,500 lb. water forming the normal vat-load. As a result, the boil acidities given in Table II have a somewhat different significance from those met with in normal production.

PULPING, and Finishing

Each batch of N.C. was passed through two Jordans in series, the concentration being approximately 0.9 lb./gallon. No observations of particular note arose from this operation; and satisfactory fineness was achieved. The short boil 12.2 N.C. was given a second passage through the Jordans, but this had little effect on settling test - 74, decreased to 71.

At the completion of the Jordan treatment, the "short boil" (U.K.) nitrocelluloses were passed directly to a tub where they were washed by decantation and then to the Packer vibratory screen, over the blanket run, and finally washed on the rotary vacuum filter prior to wringing for despatch to Maribyrnong.

In the case of the "long boil" (U.S.) nitrocellulose, the Jordan treatment was followed by the customary "poaching", comprising boilings in vats with cone stirrers, as follows:-

One boil of 4 hrs. with 0.02% Na_2CO_3 solution
One boil of 2 hrs. with fresh water
Two boils of 1 hr. each, with fresh water

After this, the N.C. passed on to the Packer screen, blanket run, and vacuum filter as above.

Analytical results on the finished N.C's are given in Table I, and boil liquor test results in Table II.

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TABLE I

ANALYTICAL RESULTS - FINISHED NITROCELLULOSE

Batch	MVP Test Mins.	B & J Test (mgm N/gm)	Heat Test Mins.	Nitrogen Lunge %	Ash %	Alkalinity % $CaCO_3$	Soluble in E.A. %	Organic Insoluble in Acetone	Viscosity secs.	Settling Test Mls.	Sulphate % H_2SO_4
"Short" boil" SP8	30	0.99	25	12.29	0.39	0.22	99.5	0.32	9	73	0.06
"Long" boil" SP7	30	1.02	25	12.19	0.23	0.02	99.6	0.20	4	71	0.02
"Short" boil" G4	25x	1.95x	10x	13.17x	0.23x	0.05x	15.1x	0.10x	59x	77x	0.13x
"Long" boil" G3	30x	0.97x	21x	13.12x	0.20x	0.005x	18.5x	0.10x	10x	80x	0.05x

x Data for original products,
U.K. subsequently boiled again 2 x 4 hrs.

MIXED ACID COMPOSITION

BATCH		H_2SO_4	HNO_3	HNO_2	H_2O	DILUTION
12.2N N.C.	(1)	59.69	23.61	0.71	15.99	16.70
	(2)	59.92	23.34	0.73	16.01	16.74
13.1N N.C.	(1)	60.56	26.51	0.72	12.21	12.93
	(2)	60.41	26.55	0.73	12.31	13.04
	(3)	60.59	26.41	0.66	12.34	13.00

TABLE II

TABLE OF ACIDITIES AND ALKALINITIES

(a) During U.K. Stabilisation

ACIDITIES 12 hr. Acid Boil							ACIDITIES 12 hr. water boil		ALKALINITIES 1st 4 hr. alk.boil				ALKALINITIES 2nd 4 hr. alk.boil			
12.2 N.C.	0 hr.	2 hrs.	4 hrs.	6 hrs.	8 hrs.	10 hrs.	12 hrs.	4 hrs.	12 hrs.	1 hr.	2 hr.	3 hr.	4 hr.	1 hr.	2 hr.	3 hr.	4 hr.
	0.09	0.11	0.11	0.12	0.12	0.12	0.13	0.008	0.004	0.017	-	0.017	0.012	0.015	0.012	0.007	0.005
13.1 N.C.	0.05	0.12	0.11	0.13	0.13	0.16	0.14	0.05	0.04	.....			0.007	.....			0.004

(b) During U.S. Stabilisation

ACIDITIES Acid Boil																	
12.2 N.C.	2 hr.	10 hr.	30 hr.	50 hr.	40 hrs.												
Acid Boil/0.59	0.59	0.45	-														
13.1 N.C. 60 hours																	
Acid Boil/0.47	0.50																

105/R/47 Appendix 3

PROGRESS REPORT ON PROJECT E.C. 1419

by A.L. Lovecy

March 31st 1947

At the 21st meeting of the E.C., it was agreed that provision be made for a comparison between the U.S. procedure for stabilisation of Nitrocellulose and the U.S. procedure, in conjunction with the nitrations of Paper Wood Cellulose Board to 12.2% and 13.1% N.C's under Project E.C. 1417. As the quantities of N.C. being produced for that project are relatively small, it was decided to carry out the U.K. boils on the same scale as the U.S. boils; leaving open the question whether the N.C's boiled by U.K. process should be converted into all the natures of cordite called for under E.C. 1417, or only a selected set of items. In particular, it was considered that the outcome of the comparison of boilings will enable a decision to be reached as to which scheme shall be adopted for the manufacture of 12.2 N.C. required for rocket charges under E.C.1417, as this manufacture is not required immediately.

Accordingly, twin batches of approx. 2,000 lb. 12.2 N.C., and twin batches of approx. 3,800 lb. 13.1 N.C. have been nitrated (see Progress Report on Project E.C.1417). One batch of each N-content has been stabilised in accordance with the U.S. methods, the remaining batches being treated according to U.K. procedure. Actually, since the plant at Mulwala is designed in conformity with U.S. practice, it was not possible to simulate in exact detail the U.K. conditions of stabilisation laid down in C.S.1154. However, it is considered that the desired conditions were sufficiently closely attained for a valid comparison to be made. For completeness of record, the following items in which some departure from the C.S.1154 conditions could not be avoided are noted:-

1. Absence of lining of vat - this provision has been waived in U.K., however, as a war-time measure.

2. Due to the small size of N.C. batch, the water/N.C. ratio was abnormally high.

3. Instead of upward displacement between boilings, draining and re-filling of vats was adopted.

4. Owing to the high acidity of the N.C. slurry entering the vat from the drowning-tub, a preliminary cold washing was instituted, to give an arbitrary liquor-acidity value of $\triangleright$ 0.1%, calc. as H_2SO_4, at the outset. Normally, the acidity at this stage is not controlled.

5. The second boil was carried out with ordinary process water, without alkali added; U.K. practice generally employs calcareous water, of specification alkalinity, for all boils.

6. The alkalinity of water used in the third and fourth boils was provided by adding the calculated requirement of Na_2CO_3 (in solution) during the filling of the vat.

7. In pulping the N.C., after completion of boiling, Jordans were used instead of hollander beaters.

8. Instead of the usual washings in potchers, of the vortex or paddle types, two decantation washes were carried out, in tubs with cone-stirrers, and followed by a final wash on a rotary vacuum filter.

The results at present available are summarised below:-

N.C. Type	Stab.	N % Corr.	Ash %	Acetone Insol.	E.A. Sol.	B & J	Heat Test	M.V. Test
12.2	U.S.	12.19	0.23	0.20	99.6	1.02	25	30'
	U.K.	12.29	0.39	0.32	99.5	0.99	25	30'

Additional information, on 11.4.47:-

13.1	U.S.	13.09 (uncorr.)				0.97		
	U.K.	13.17	0.23	<0.1	15.1	1.95		25'

General comments and observations arising from the trial manufacture of N.Cs. types A and B from B.W.C. (Project E.C.1417).April 2nd 1947

by A.L.Lovecy

The following notes supplement the Progress Reports dated March 31st, which for reasons of clarity, were limited to a description of operations carried out and results obtained, with only a minimum of comment and no general discussion. The present comments are not confined to the trial alone but include some more general remarks on the plant and processes, and comparisons with U.K. practice; the various manufacturing operations are dealt with in their normal sequence.

As regards raw material, it was realised from the outset that the P.W.C.B. supplied (Cons. 202) was undesirably hard. After preliminary experiments it was decided to continue the main trial with this material, to avoid the delay inevitable if fresh board were ordered. With this hard board, normal shredding did not "open up" the texture to a satisfactory extent. By reducing the shredder feed-roll speed a considerable improvement was effected but even at the lowest speed (ca. half maximum) there was an appreciable amount of dense "stringy" shred formed. Quite apart from any other consideration, the physical nature of this board puts up the cost of shredding due to reduced output per kwh.

Turning to the nitration stage, the results of pot nitrations showed excessive acetone-insoluble in seven out of eight nitrations of 30 minutes duration, whereas parallel nitrations of 60 minutes duration gave acceptable acetone-insoluble values in seven out of eight cases. This behaviour is evidently due to the dense nature of the shred hindering the penetration of acid, so slowing-down the attainment of equilibrium. As excessive acetone-insoluble occurred in short "13.1" nitrations as well as "12.2", the unevenness of nitration is more dependent on the time than on the acid composition. Hence the extension of nitration-time to one hour was adopted throughout the trial. Obviously the nitrator throughput is reduced to about 50 per cent. by this change, and the usual balance between nitration and wringing cycles is upset.

Evidently board of a softer quality is needed for satisfactory output; some difficulty of this kind was foreseen when the project was initiated - see O.B.Proc.33,931. It is considered (on the basis of experience gained in the development of the "break-up" wad for S.A.A.) that the requisite quality should be obtainable by adjusting the board-making conditions. In particular, the pressures at the couch and wet-press rolls should be kept low, even if this entails a reduction in finished caliper to comply with the moisture-specification. The object should be to approximate the lower limit of the specified weights/sq.ft. per 0.01 inch. It also seems desirable that the Mullen burst specification be given in terms of lb./sq.inch per 0.01 inch thickness if possible, rather than unrelated to caliper as at present.

After boiling, the N.C. is pumped directly to the boiling vats, in the acid drowning liquor. For the U.S. method of boiling, requiring a fairly high initial liquor acidity, this procedure is fairly satisfactory. Adjustment to the desired acidity-value is readily done by partially draining and refilling the vat. This practice seems by no means ideal from the point

of view of uniformity of treatment as between individual vat-loads, since considerable variation is inevitable in the acidities of liquors and the periods of contact with them prior to boiling. Variations in the treatment accorded individual vat loads must also arise from the practice of adjusting acidity during the actual boiling, by partial replacement of liquor. In principle, it should be possible to eliminate the second source of variation by a sufficiently close control of the initial acidity, though the use of unlined vats militates against this, owing to leakage. In U.K. practice, of course, the "external acidity" is fairly completely removed from the N.C. before boiling begins, as a result of the Thomson displacement process. To simulate this condition in the U.K. boilings of the trial, the drowning-liquor was drained from the vat, which was then re-filled with fresh water, drained, and again filled, in order to obtain an initial (cold) liquor acidity below 0.1 per cent. as H_2SO_4. It is well established that external or liquor acidity contributes relatively little to the stabilising process; the acidity occluded within the N.C. exerts the major effect. Consequently it would seem sound in principle to drain off the liquor at the drowning-vat and pump to the boiling vats in fresh water, thereby avoiding the variations in treatment mentioned above. The relatively high liquor acidity in the U.S. method (0.25 to 0.5 per cent., as compared to U.K. 0.05 to 0.2 per cent.) does, of course, have the effect of reducing the viscosity of the N.C. but it is not clear whether this is a deliberate objective of the scheme prescribed. Bearing in mind that a still longer acid boil is given to the "insoluble" component of the N.C. blend used for single base propellants, it seems unlikely that viscosity-control is the main objective. A further point which may be of interest is that a prolonged acid boil would tend to destroy acetone-insoluble, under-nitrated material. Viewed as a whole, the system of stabilisation-boilings laid down in the U.S. specification seems capable of considerable modification in the interests of economy and of uniformity of product.

In U.K., the whole of the stabilisation-boiling, including the alkaline boils, is completed before pulping ("beating") the N.C. Work carried out in A.R.D. some years before the War, however, showed that by interposing the pulping between the acid and alkaline boils, a saving in over-all time of boiling could be made, and it is intended to devote further attention to this procedure. Thus on the basis of existing information it appears that the U.S. order of operations is correct in principle, but could be curtailed substantially.

The use of Jordans for pulping nitrocellulose is radically different from U.K. practice, and several points are worthy of notice in this connection. Firstly, the Jordan is only applicable directly to material already in a sub-divided state, such as the shredded pulp, disintegrated pulp, or cotton linters, which are the normal materials used in mechanical nitration. When scroll paper or cotton waste are employed, as in U.K. displacement plants, the hollander beaters used are capable of receiving the product directly, whereas Jordans would necessitate some preliminary "breaking" treatment being applied. Secondly, the Jordans act upon any given portion of a batch for a short period only, whereas in the hollander the material circulates, receiving shearing, crushing and blending treatment, during many hours. Hence, to whatever degree the removal of internal acidity, or adherent impurities may be assisted by this mechanical action, the hollander offers advantages over the Jordan. Thirdly, from the viewpoint of controlling the uniformity of the pulping action, the batchwise operation of the hollander is preferable to the continuous flow through the Jordan, where the action may vary unobserved during the passage of a batch, due to changes in speed of flow, consistency etc. As regards power usage, the comparison appears unfavourable to the Jordan, which takes approximately 1 hour to pulp 1000 lb.

using a 300 h.p. motor, i.e. 220 k.w.h./1000 lb. whereas hollander beaters take 170-180 k.w.h./1000 lb. It is of course unlikely that the Jordan motor is run at full rated load, but since two Jordans in series are normally used, the above estimate is very conservative. Clearly, the first cost, maintenance, and labour usage must also be taken into account in order to make an effective comparison, but that is beyond the scope of these notes.

After completion of stabilisation treatment, the pulped N.C. is always subjected to certain final purification processes, involving washing, removal of magnetic and heavy particles, and screening. The screening, which is not included in U.K. practice, comprises passing the N.C. slurry through slots 0.022" wide and 4" long in a vibratory bronze screen-plate. Very little is normally retained on the screen apart from accidental contamination such as chips of wood from tubs, etc. In view of this, it would seem logical to carry out the screening at as late a stage as possible, e.g. between the final slurry tub and the wringers at the despatch room. Actually, in the U.S. design, the screen precedes the blanket-run, etc., and no reason is seen for this; the situation would be understandable if any considerable proportion of over-size N.C. were being retained on the screens. In U.K. practice, the blanket-run has been superseded by centrifugal apparatus ("Purifuge" and "Erkensator") for the removal of heavy particles, while compact electromagnets have taken the place of the spaced-out bar magnets originally used in the blanket-run. In these respects the arrangements at Mulwala seem rather out of date; nevertheless, past experience shows that such simple equipment can be thoroughly effective. After the screen and blanket-run, the N.C. undergoes a de-watering and spray-washing treatment on a vacuum rotary filter according to U.S. practice; this is in advance of U.K. procedure, so far as removal of soluble impurities is concerned. Presumably a proportion of light, suspended particles are also removed with the water in this process, which thus serves a similar purpose to decantation-washing; the suitability of one or the other method for removing scum-forming material (of dubious stability) is clearly dependent on the circumstances of each individual factory, and no general preference can be expressed a priori.

According to present arrangements, the N.C. is finally de-watered in centrifugals of the overhead-drive type, and discharged through base vents by means of hand-operated ploughs, being then packed in rubberised bags and transported by road to Maribyrnong. The moist N.C. received there is put through a thorough blending treatment on a "quartering" principle, using a simple rotary mechanical "breaker" in the process. For full-scale operation, the N.C. would then be converted to slurry, at 1.1 lb./gallon, in the large blend-tanks and pumped through the ring-main to the mixing-houses. The stages from finished N.C. at Mulwala to the slurry-feed at Maribyrnong mixing-houses are of course very different from the usual transport within U.K. solventless plants of the ring-main type, in which the N.C. is maintained in slurry form from the beaters onward. However, it is noted that no rotary-drum blending of the wrung N.C. is involved, and from the appearance of the N.C. as fed to the slurry-tanks it is considered that a fully satisfactory homogeneous suspension is obtainable by the methods in use. Thus there is no reason to anticipate speckiness arising directly from the nature of the operations involved, provided due attention is given to ensuring uniform dispersion of the slurry supplied to the ring-main, as at present.

Manufacturing data for Nitrocellulose lot SP7

Drying and shredding BNC Consignment 202

	Temperature Drying Chamber	210 - 250°F.
	Temperature Plenum Chamber	310 - 350°F.
	Clearance between Shredder Blades	0.013" cold

Mixed Acid	Analysis	H_2SO_4	59.8%
		HNO_3	23.48%
		HNO_2	0.72%
		H_2O	16.00%
		Dilution	16.72

Nitration House	Dipping Pot Charge (Dry Pulp)	40 lb.
	Wt. of Acid	1760 lb.
	Dipping Cycle	60 mins.
	Temp. (Taylor Recorder)	32°C.
	Wringing L.S. after charging	1/2 mins.
	Wringing H.S. after charging	3.1/2 mins.

Boiling Tub House	Tub Charge	2000 lb.
	Boiling 1 No. 40 hrs. & 2 No.5 hours	
	Acidity 40 hr. Boil	0.25 - 0.50% H_2SO_4
	Wt. Na_2CO_3 at Slurry Tub	2 lb.

Pulping House	Pulping	2 Jordans in series and held in stuff tank for test.
	Drainage at 40°C.	110 secs.
	Wt. Na_2CO_3 at Initial Stuff tank	4 lb.

Poacher Tub House	Alkalinity 4 hr. boil	0.02 %
	Boiling 1 No. 4 hrs. 1 No.2 hrs. 2 No.2 hr.	

Wringer House	Wringing at H.S.	1.1/2 mins.
	Moisture Content	About 42%

Manufacturing data for Nitrocellulose lot SP8

Drying and shredding — B.C Consignment 202

Temperature Drying Chamber	210 - 250°F.
Temperature Plenum Chamber	310 - 350°F.
Clearance between Shredder Blades	0.013" cold

Mixed acid

Analysis		
	H_2SO_4	59.8%
	HNO_3	23.48%
	HNO_2	0.72%
	H_2O	16.00
	Dilution	16.72

Nitration House

Dipping Pot Charge (Dry Pulp)	40 lb.
Wt. of Acid	1760 lb.
Dipping Cycle	60 mins.
Temp. (Taylor Recorder)	32°C.
Wringing L.S. after charging	1/2 min.
Wringing H.S. after charging	3.1/2 mins.

Boiling Tub House

Tub Charge 2,000 lb.
Boiling 1 x 12 hr. (97°C. min.) 1 x 12 hr. neutral boil (97°C. min) 2 x 4 hr. alk. boils (97°C. min.)
Acidity 12 hr. boil = 27 ± 3 parts. $CaCO_3$ per 100,000 0.05 - 0.20 at end of boil.
Wt. Na_2CO_3 at Slurry Tub - lb.

Pulping House

Pulping 2 Jordans in series followed by 1 Jordan and held in Initial Stuff Tanks for fineness test.

Drainage at 40°C.	110 secs.
Wt. Na_2CO_3 at Initial Stuff tank	-

Poacher Tub House

Double decant in poacher tub and then pass over grit run and vacuum filter.

Wringer House

Wringing at H.S.	1.1/2 mins.
Moisture Content	About 42%

Manufacturing data for Nitrocellulose lot G3

Drying and shredding — BWC Consignment 202

Temperature Drying Chamber	210 - 250°F.
Temperature Plenum Chamber	310 - 350°F.
Clearance between Shredder Blades	0.013" cold

Mixed Acid — Analysis

H_2SO_4	60.52%
HNO_3	26.49%
HNO_2	0.70%
H_2O	12.29%
Dilution	12.99

Nitration House

Dipping Pot Charge (Dry Pulp)	25 lb.
Wt. of Acid	1100 lb.
Dipping Cycle	60 mins.
Temp. (Taylor Recorder)	32°C.
Wringing L.S. after charging	1/2 mins.
Wringing H.S. after charging	2.1/2 mins.

Boiling Tub House

Tub Charge	4,000 lb.

Boiling 1 hr. x 60 hr. plus
2 x 5 hr. water boils
Acidity 60 hr. boil 0.25 - 0.50% H_2SO_4
Wt. Na_2CO_3 at Slurry Tub 2 lb.

Pulping House

Pulping 2 Jordans in series and return to stuff tank.

Drainage at 40°C.	110 secs.
Wt. Na_2CO_3 at Initial Stuff tank	4 lb.

Poacher Tub House

Alkalinity 4 hr. boil	0.02%

Boiling 1 x 4 hr. 1 x 2 hr. and 2 x 1 hr. boils.

Wringer House

Wringing at H.S.	1.1/2 mins.
Moisture content	About 42%

Manufacturing data for Nitrocellulose lot G4

Drying and shredding BWC Consignment 202

Temperature Drying Chamber	210 - 250°F.
Temperature Plenum Chamber	310 - 350°F.
Clearance between Shredder Blades	0.013" cold

Mixed Acid

Analysis		
	H_2SO_4	60.52%
	HNO_3	26.49%
	HNO_2	0.70%
	H_2O	12.29%
	Dilution	12.99

Nitration House

Dipping Pot Charge (Dry Pulp)	25 lb.
Wt. of Acid	1100 lb.
Dipping Cycle	60 mins.
Temp. (Taylor Recorder)	32°C.
Wringing L.S. after charging	1/2 mins.
Wringing H.S. after charging	2.1/2 mins.

Boiling Tub House

Tub Charge 4,000 lb.
Boiling 97°C. 1 x 12, 1 x 12 water, 2 x 4 alkaline
≡ 27 ± 3 parts per 100,000 $CaCO_3$
Acidity 12 hr. Boil 0.05 - 0.20% H_2SO_4
Wt. Na_2CO_3 at Slurry Tub 2 lb.

Pulping House

Pulping 2 Jordans in series and returned to Stuff tank.
Drainage 110 secs.
Wt. Na_2CO_3 at Initial Stuff Tank 4 lb.

Poacher Tub House

Double decant in poacher tub and pass over vacuum filter

Wringer House

Wringing at H.S.	1.1/2 mins.
Moisture Content	About 42%

Manufacturing data for Nitrocellulose lot SP9

Drying and shredding — BWC Consignment 202

Temperature Drying Chamber	210 - 250°F.
Temperature Plenum Chamber	310 - 350°F.
Clearance between Shredder Blades	0.013" cold

Mixed Acid

Analysis	H_2SO_4 58.1 ± 0.1 % HNO_3 25.1 ± 0.1 % Dilution 16.8 ± 0.1 %

Nitration House

Dipping Pot Charge (Dry Pulp)	40 lb.
Wt. of Acid	1760 lb.
Dipping Cycle	60 mins.
Temp. (Taylor Recorder)	32°C.
Wringing L.S. after charging	1/2 mins.
Wringing H.S. after charging	3.1/2 mins.

Boiling Tub House

Tub Charge	7,500 lb.

Boiling @ 97°C. 1 x 12 hr. acid 1 x 12 hr. water
2 x 4 hr. alkaline ≡ 27 ± 3 parts/100,000 $CaCO_3$

Acidity 1st 12 hr. Boil	0.05% - 0.20% H_2SO_4
Wt. CaCO3 at Slurry Tub	2 lb.

Appendix 4

Detailed Programmes of Storage, Testing and Firing of Gun-cordite Items

Summary

Project E.C.1417
O.B.P. 33931.Trial No.333

Firing and testing: at 0, 6, 12, 24, 36 and 48 months.
1 lb. for V.M.: at 1, 2, 3, 4, 5, 6, 9, 12, 18, 24, 30, 36, 42 and 48 months.

Warmers and charges of the propellant under trial for use in charge determination not included.

Item No.	Cordite	Gun	Gun No.	Gross amount of propt. (lb.)	Standard	No. of rds. of std. (inc. 5 for charge detn.)	No. of charges to be made up.	Container	No. for firing at 0 months	No. for exam. at 0 months	No. of charges and bulk propellant for storage Charges / Bulk (lb.)	Storage temp. (°F.)	No. of charges for firing at each period	No. of charges for testing at each period
5	S.C.109	Q.F. 4.7" Mk.12B	2575	2000 A. 2000 U.K.	S.C.109 MEC 175	41	112	Cambric bag *	5	2	35 / 50 35 / 50 35 / 50	80 100 120	5 5 5	2 2 2
6	NFQ/S 168-048	Q.F.4.7" Mk.12B	2697	2100A. 2100 U.K.	NFQ/S 168-048 RNC4770	41	112	Cambric bag *	5	2	35 / 50 35 / 50 35 / 50	80 I.S.A(A) 120	5 5 5	2 2 2
7	MNF/S 168-048	Q.F. 4.7" Mk.12B	2698	2100 A. 2100 U.K.	NFQ/S 168-048 RNC4770	41	112	Cambric bag *	5	2	35 / 50 35 / 50 35 / 50	80 I.S.A(A) 120	5 5 5	2 2 2
8	WM 017	Q.F. 25-pr. Mk.2. Charge 1	Not notified	170 A. 170 U.K.	WM017 MS 222	41	165	Service bag	5	10	50 / 25 50 / 25 50 / 25	80 100 120	5 5 5	5 5 5
9	WM017 and WM061	Q.F.25-pr. Mk.2. Charge 3	Not notified	170(-017) 450(-061) A. 170(-017) 450(-061) U.K.	WM017 MS222 WM061 MS225	41	165-017 159 B & W 061	Service bags	5	10-017 4-061	50 / (25 017 + 50 061) 50 / (25 017 + 50 061) 50 / (25 017 + 50 061)	80 100 120	5 5 5	5 5 5
10	MT 211-100	Q.F.25-pr. Mk.2. Supor.	Not notified	550A. 550 U.K.	MT 211-100 MK 471	41	112	Cambric bag *	5	2	35 / 50 35 / 50 35 / 50	80 100 120	5 5 5	2 2 2
11	N/S 164-048	Q.F.3.7" Mk.2	Not notified	1400A. 1400 U.K.	N/S 164-048 Not notified	41	112	Cambric bag *	5	2	35 / 50 35 / 50 35 / 50	80 I.S.A(A) 120	5 5 5	2 2 2
12	NQ018	Q.F.25-pr. Mk.2. Charge 1	Not notified	200A. 200 U.K.	NQ/R 014 T3835	41	165	Service bag	5	10	50 / 25 50 / 25 50 / 25	80 I.S.A(A) 120	5 5 5	5 5 5
13	NQ 018 and NQ 050	Q.F. 25-pr. Mk.2. Charge 3	Not notified	200(-018) 500(-050) A. 200(-018) 500(-050) U.K.	NQ/R014 T3835 NQ050 T3785	41	165-018 159 B & W 050	Service bags	5	10-018 4-050	50 / (25 018 + 50 050) 50 / (25 018 + 50 050) 50 / (25 018 + 50 050)	80 I.S.A(A) 120	5 5 5	5 5 5
14	NQ/S 134-040	Q.F. 25-pr. Mk.2. Supor.	Not notified	600A. 600 U.K.	NQ/S 134-040 D10286	41	112	Cambric bag *	5	2	35 / 50 35 / 50 35 / 50	80 I.S.A(A) 120	5 5 5	2 2 2
6	NQF/P 128	B.L.6" Mk.23	4896	5100 A. 5100 U.K.	NQF/P128 RNP 1450	41	112	Service silk bag	5	2	35 / 100 35 / 100 35 / 100	80 I.S.A(A) 120	5 5 5	2 2 2

* Cambric bags to be removed before making into rounds for firing.

105/R/47 Appendix 4

PROJECT E.C. 1417

O.B.PROC. 33931, ITEM 5

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE S.C.109 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1.	Gun Q.F. 4.7" Mk.12B No.2575	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite S.C.109 Lot ..... Gross amount required: 2000 lb. for make-up in Australia 2000 lb. for despatch in bulk to U.K.	E.F.M.
4.	Substitute ballistic standard for trial Cordite SC109 Lot MEC.175 No. of rounds required 41 (including 5 rounds for charge-determination)	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite SC109 Lot ..... by proof against lot MEC.175 in a Cordite Proof Gun	P. & E.O.
6.	Make-up of Charges 112 Charges Cordite SC109 lot ..... to be made up without igniters, decoppering alloy etc. at the A.C.W. and each inserted in a cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F., 5 rounds (at the A.C.W.) of Cordite SC109 Lot ..... (A) against Lot MEC.175(T). Order of fire; W.T. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, firing-interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 2 charges of Cordite SC 109 Lot ..... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination Breaking radius ratio test Calorimetric value	M.S.L.

V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic storage

(A) 35 charges Cordite SC 109 Lot .... to be stored in cambric bags supported on bearers in open wooden cordite boxes, and 50 lb. Cordite SC 109 Lot ... to be stored in a wooden cordite box at 80°F. without maintained humidity. — M.S.L.

(B) as (A) but stored at 100°F. without maintained humidity.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6, 12, 24, 36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up without the cambric bags into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B and 2C charges are to be removed for physical and chemical examination.

After 1, 2, 3, 4, 5, 6, 9, 12, 18, 24, 30, 36, 42 and 48 months, 1 lb. of Cordite SC 109 Lot ..... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.

At each period fire at 80°F. the 5A, 5B, 5C rounds against the ballistic standard for the trial (T).

Order of Fire: WT + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
* firing interval.

12. Physical and Chemical Examination during Climatic Storage — M.S.L.

The 2A, 2B, 2C charges removed after 6, 12, 24, 36 and 48 months are to be examined as follows:-

Visual examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.
Chemical analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite SC 109 Lot ..... removed after storage in bulk at each temperature for 1,2,3,4,5, 6,9,12,18,24,30,36,42 and 48 months is to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C. 1417

O.B.PROC. 33931, ITEM 6

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE NFQ/S 168-048 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)

PROGRAMME

		Department Responsible
1.	Gun Q.F. 4.7" Mk.12B No.2697	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite NFQ/S 168-048 Lot ....Gross amount required: 2100 lb. for make-up in Australia; 2100 lb. for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial. Cordite NFQ/S 168-048 Lot RNC 4770 No. of rounds required 41 (including 5 for charge determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite NFQ/S 168-048 Lot .... by proof against Lot RNC 4770 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of Charges 112 charges Cordite NFQ/S 168-048 Lot .... to be made up without igniters, decoppering alloy etc. at the A.C.W. and each inserted in a cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F., 5 rounds (at the A.C.W.) of Cordite NFQ/S 168-048 Lot ... (A) against Lot RNC 4770 (T).	P. & E.O.
	Order of fire; W.T. + (AT) x 5	
	Observe: M.V., pressure, unburnt, debris, firing-interval.	
8.	Physical and chemical examination at commencement of climatic storage 2 charges of Cordite NFQ/S 168-048 Lot .... to be examined as follows:-	M.S.L.

Visual examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value

V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical analysis
Heat Test
H Water Extract Test (electrometric)
H Colour Test
H 80°C. Accelerated Heating Trial

9. Climatic Storage — M.S.L.

(A) 35 charges Cordite NFQ/S 168-048 Lot ..... to be stored in cambric bags supported on bearers in open wooden cordite boxes and 50 lb. Cordite NFQ/S 168-048 Lot ..... to be stored in a wooden Cordite box at 80°F. without maintained humidity.

(B) As (A) but stored under I.S.A.(A) conditions

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6, 12, 24, 36 and 48 months -

(i) 5A, 5B, and 5C charges to be removed and made up without the cambric bags into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B, and 2C charges are to be removed for physical and chemical examination.

After 1, 2, 3, 4, 5, 6, 9, 12, 18, 24, 30, 36, 42 and 48 months 1 lb. of Cordite NFQ/S 168-048 Lot .... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.

At each period fire at 80°F. the 5A, 5B, 5C rounds against the ballistic standard for the trial (T).

Order of Fire: WT + (A,B,C,T) x 5.

Observe: M.V. pressure, unburnt, debris,
H firing interval.

12. Physical and Chemical Examination during Climatic Storage — M.S.L.

The 2A, 2B, and 2C charges removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual Examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46.
Chemical analysis
Heat Test
⁂ Water Extract Test (electrometric)
⁂ Colour Test

The 1 lb. Cordite NFQ/S 168-048 Lot ..... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months is to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46

⁂ Tests marked ⁂ may be omitted if inconvenient to apply.

PROJECT E.C.1417

O.B.PROC. 33931, ITEM 7

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE MNF/S 168-048 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1.	Gun Q.F. 4.7" Mk.12B No.2698	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite MNF/S 168-048 Lot .....Gross amount required 2100 lb. for make-up in Australia 2100 lb. for depatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite NFQ/S 168-048 Lot RNC 4770.No. of rounds required 41 (including 5 for charge determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite MNF/S 168-048 Lot ... by proof against Lot RNC 4770 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of charges 112 charges Cordite MNF/S 168-048 Lot .... to be made up without igniter, deecoppering alloy etc. at the A.C.W. and each inserted in a cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite MNF/S 168-048 Lot ... (A) against Lot RNC 4770 (T). Order of fire; W.T. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, firing-interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 2 charges of Cordite MNF/S 168-048 Lot .... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination Breaking radius ratio test Calorimetric value	M.S.L.

V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
H Water Extract Test (electrometric)
H Colour Test
H 80°C. Accelerated Heating Trials

9. Climatic storage — M.S.L.

(A) 35 charges Cordite MNF/S 168-048 Lot .... to be stored in cambric bags supported on bearers in open wooden cordite boxes and 50 lb. Cordite MNF/S Lot..to be stored in a wooden Cordite Box at 80°F. without maintained humidity.

(B) As (A) but stored under I.S.A.(A) conditions.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up without the cambric bags into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B and 2C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months 1 lb. of Cordite MNF/S 168-048 Lot ... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.
At each period fire at 80°F. the 5A, 5B, 5C rounds against the ballistic standard for the trial (T).

Order of fire: W.T. + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris
H firing interval.

12. Physical and Chemical Examination during climatic storage — M.S.L.
The 2A, 2B and 2C charges removed after 6,12,24, 36, and 48 months are to be examined as follows:

105/R/47 Appendix 4

Visual Examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite MNF/S 168-048 Lot .... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12,18,24,30,36, 42 and 48 months is to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46.

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C.1417

O.B.PROC. 33931, ITEM 8

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE WM 017 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1a.	Gun Q.F. 25-pr. Mk.2	P. & E.O.
1b.	Charge Charge 1	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite WM 017 Lot .....Gross amount required 170 lb. for make-up in Australia) 170 lb. for despatch in bulk to U.K.)	E.F.M.
4.	Ballistic standard for trial Cordite WM 017 Lot M.S.222.No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite WM 017 Lot ..... by proof against Lot M.S.222 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of Charges 165 charges Cordite WM 017 Lot .... to be made up without igniters, decoppering alloy etc. at the A.C.W. each in its Service cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite WM 017 Lot .... (A) against Lot MS.222(T)) Order of fire; W.T. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, firing-interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 10 charges of Cordite WM 017 Lot ... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination	M.S.L.

Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic storage — M.S.L.

(A) 50 charges Cordite WM 017 Lot .... to be stored in cambric bags supported on bearers in open wooden cordite boxes and 25 lb. Cordite WM.017 Lot .... to be stored in a wooden Cordite box at 80°F. without maintained humidity.

(B) As (A) but stored at 100°F. without maintained humidity.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up in the cambric bags used for storage into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 5A, 5B and 5C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months 1 lb. of Cordite WM 017 Lot.... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.

At each period fire at 80°F. the 5A, 5B, 5C rounds against the ballistic standard for the trial (T).

Order of fire: W.T. + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
* firing interval.

12. Physical and Chemical Examination during Climatic Storage — M.S.L.

The 5A, 5B, and 5C charges removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical analysis
Heat Test
¤ Water Extract Test (electrometric)
¤ Colour Test

The 1 lb. Cordite WM.017 Lot ..... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months is to be examined for V.M. by
(a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.

¤ Tests marked ¤ may be omitted if inconvenient to apply.

PROJECT E.C.1417

O.B.PROC. 33931, ITEM 9

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE WM.017 and 061 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1a.	Gun Q.F. 25 pr. Mk.2 No.	P. & E.O.
b.	Charge Third	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite WM.017 and 061 Lots .... Gross amount required (170 lb. WM.017) (450 lb. WM.061) for make-up in Australia; 170 lb. WM.017) 450 lb. WM.061) for despatch in bulk to U.K	E.F.M.
4.	Ballistic standard for trial Cordite WM.017 Lot MS 222 and WM.061 Lot MS.225.No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite WM.017 and 061 Lots ... by proof against Lots MS.222 and 225 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of Charges 165 1st Charges Cordite WM.017 Lot ... and 159 "White Bags" and 159 "Blue Bags" Cordite WM.061 Lot ... are to be made up without igniters, de-coppering alloy etc. at the A.C.W. each in its Service cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite WM.017 and 061 Lots .... (A) against Lots MS.222 and 225 (T). Order of Fire: W.T. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, firing interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 10 charges of WM.017 Lot ... and 4 charges of WM.061 Lot ... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference"	M.S.L.

Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic Storage

(A) 50 third charges Cordite WM 017 and 061 to be stored in cambric bags supported on bearers in open wooden cordite boxes, and 25 lb. Cordite WM 017 Lot .... and 50 lb. Cordite WM 061 Lot ... are to be stored in a wooden Cordite box at 80°F. without maintained humidity. M.S.L.

(B) As (A) but stored at 100°F. without maintained humidity.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage M.S.L.

After 6,12,24,36 and 48 months -

(i) 5A, 5B, and 5C charges are to be removed and made up into rounds for firing. (The charges are to be weighed before and after making up to ensure that no Cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 5A, 5B and 5C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months, 1 lb. of Cordite WM 017 Lot ... and 1 lb. WM 061 Lot .... are to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage P. & E.O.

At each period fire at 80°F. the 5A, 5B and 5C rounds against the ballistic standard for the trial (T).

Order of fire: WT + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
* firing interval.

12. Physical and Chemical Examination during Climatic Storage — M.S.L.

The 5A, 5B and 5C rounds removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual Examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite WM.017 Lot .... and the 1 lb. Cordite WM.061 Lot ... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12,18, 24,30,36,42, and 48 months are to be examined for V.M. by (a) Specification methods
(b) Methods of A.R.D. Explosives Report No.214/46

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C.1417

O.B.PROC. 33931, ITEM 10

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE W.M.T. 211-100 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)

PROGRAMME

		Department Responsible
1a.	Gun Q.F. 25-pr. Mk.2 No.....	P. & E.O.
1b.	Charge Super	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite W.M.T. 211-100 Lot .... Gross amount required 550 lb. for make-up in Australia; 550 lb. for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite W.M.T.211-100 Lot DK 471.No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite W.M.T.211-100 Lot ..... by proof against Lot DK.471 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of charges 112 charges Cordite W.M.T.211-100 Lot .... to be made up without igniters, decoppering alloy etc. at the A.C.W. and each inserted in a cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite W.M.T.211-100 Lot .... (A) against Lot DK.471 (T) Order of fire: WT + (AT) x 5 Observe: M.V. pressure, unburnt, debris, firing interval.	P. & E.O.
8.	Physical and Chemical examination at commencement of climatic storage 2 charges of Cordite W.M.T.211-100 Lot .... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination Breaking radius ratio test Calorimetric value	M.S.L.

V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic storage — M.S.L.

(A) 35 charges Cordite WMT.211-100 Lot ....
to be stored in cambric bags supported on bearers in open wooden cordite boxes and 50 lb. Cordite W.M.T.211-100 Lot .....
to be stored in a wooden Cordite box at 80°F. without maintained humidity.

(B) As (A) but stored at 100°F. without maintained humidity.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from Climatic Storage — M.S.L.
After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up without the cambric bags into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B and 2C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months 1 lb. of Cordite W.M.T.211-100 Lot ... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.
At each period fire at 80°F. the 5A, 5B and 5C rounds against the ballistic standard for the trial (T).

Order of fire: W.T. + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
* firing interval.

12. Physical and chemical examination during climatic storage — M.S.L.
The 2A, 2B and 2C rounds removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite W.M.T.211-100 Lot .... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months is to be examined for V.M. by
(a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C. 1417

O.B.PROC. 33931, ITEM 11

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE N/S 164-048 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1.	Gun Q.F. 3.7" Mk.2 No.	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial. Cordite N/S 164-048 Lot ... Gross amount required 1400 lb. for make-up in Australia; 1400 lb. for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite N/S 164-048 Lot ... No. of rounds required 41 (Including 5 rounds for charge-determination).	P. & E.O.
5.	Charge-determination Determine A.C.W. of Cordite N/S 164-048 Lot .... by proof against a master or current standard in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of Charges 112 charges Cordite N/S 164-048 Lot .... to be made up without igniters, deeoppering alloy etc. at the A.C.W. and each inserted in a cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite N/S 164-048 Lot .... (A) against the ballistic standard for the trial (T). Order of fire: W.T. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, * firing-interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 2 charges of Cordite N/S 164-048 Lot ... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination Breaking radius ratio test Calorimetric value	M.S.L.

V.M. by (a) Specification Method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
H Water Extract Test (electrometric)
H Colour Test
H 80°C. Accelerated Heating Trial

9. Climatic Storage — M.S.L.

(A) 35 charges Cordite N/S 164-048 Lot.... to be stored in cambric bags supported on bearers in open wooden cordite boxes and 50 lb. Cordite N/S 164-048 Lot ....to be stored in a wooden cordite box at 80°F. without maintained humidity.

(B) As (A) but stored under I.S.A.(A) conditions.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6,12,24,36 and 48 months.

(i) 5A, 5B and 5C charges to be removed and made up without the cambric bags into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B and 2C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months, 1 lb. of Cordite N/S 164-048 Lot ... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.

At each period fire at 80°F. the 5A, 5B and 5C rounds against the ballistic standard for the trial (T).

Order of Fire: WT + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
H firing interval.

12. Physical and chemical Examination during climatic storage — M.S.L.

The 2A, 2B, 2C charges removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual examination
Measurement of Cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. cordite N/S 164-048 Lot ..... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12, 18,24,30,36,42 and 48 months is to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.

* Test marked * may be omitted if inconvenient to apply.

PROJECT E.C. 1417

O.B.PROC. 33931, ITEM 12

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE NQ 018 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1a.	Gun Q.F. 25-pr. Mk.1 No.1	P. & E.O.
1b.	Charge Charge 1	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite NQ 018 Lot .... Gross amount required 200 lb. for make-up in Australia; 200 lb. for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite NQ/R 014 Lot T.3835.No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-determination Determine A.C.W. of Cordite NQ.018 Lot .... by proof against NQ/R 014 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of charges 165 charges Cordite NQ 018 Lot .... to be made up without igniters, decoppering alloy etc. at the A.C.W. in its Service cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite NQ 018 Lot .... (A) against Lot T.3835 (T) Order of fire: W.T. + (AT) x 5 Observe: M.V. pressure, unburnt, debris, firing interval.	P. & E.O.
8.	Physical and Chemical examination at commencement of climatic storage 10 charges of Cordite NQ 018 Lot ... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination Breaking radius ratio test	M.S.L.

Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic storage — M.S.L.

(A) 50 charges Cordite NQ 018 Lot.... to be stored in cambric bags supported on bearers in open wooden cordite boxes and 25 lb. cordite NQ 018 Lot .... to be stored in a wooden cordite box at 80°F. without maintained humidity.

(B) As (A) but stored under I.S.A.(A) conditions.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.
After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up in the cambric bags used for storage into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 5A, 5B and 5C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months, 1 lb. of Cordite NQ 018 Lot .... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.
At each period fire at 80°F. the 5A, 5B, 5C rounds against the ballistic standard for the trial (T).

Order of Fire: WT + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
* firing interval.

12. Physical and chemical Examination during climatic storage — M.S.L.
The 5A, 5B and 5C rounds removed after 6,12,24,

36 and 48 months are to be examined as follows:-

Visual Examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite NQ 018 Lot ..... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9, 12,18,24,30,36,42 and 48 months is to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C. 1417

O.B.PROC. 33931, ITEM 13

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE NQ 018 and 050 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1a.	Gun Q.F. 25-pr. Mk.2 No.....	P. & E.O.
1b.	Charge Third	P. & E.O.
2.	Nitrocellulose	E.F.Mulvala
3.	Propellant under trial Cordites NQ 018 and 050 Lots .... Gross amount required (200 lb. NQ.018) for make-up in Australia; (500 lb. NQ.050) for make-up in Australia; (200 lb. NQ.018) for despatch in bulk to U.K.; (500 lb. NQ.050) for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite NQ/R 014 Lot T.3835 and NQ 050 Lot T.3785.No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite NQ.018 and 050 Lots .... by proof against Lots T.3835 and T.3785 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of Charges 165 first charges Cordite NQ.018 Lot .... 159 "white bags" and 159 "blue bags" Cordite NQ 050 lot are to be made up without igniters, decoppering alloy etc. at the A.C.W. each in its Service Cambric Bag.	M.S.L.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite NQ 018 and 050 Lots .... (A) against Lots T.3835 and T.3785 (T). Order of fire: WT. + (AT) x 5 Observe: M.V. pressure, unburnt, debris, firing-interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 10 charges of NQ 018 Lot .... and 4 charges of NQ 050 lot .... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density	

Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46.
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic storage — M.S.L.

(A) 50 third charges Cordite NQ 018 and 050 Lots to be stored in cambric bags supported on bearers in open wooden cordite boxes and 25 lb. cordite NQ 018 lot ... and 50 lb. Cordite NQ 050 lot ... to be stored in a wooden Cordite box at 80°F. without maintained humidity.

(B) As (A) but stored, under I.S.A.(A) conditions.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 5A, 5B and 5C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months 1 lb. of Cordite NQ 018 Lot .... and 1 lb. NQ 050 Lot ... are to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.

At each period fire at 80°F. the 5A, 5B and 5C rounds against the ballistic standard for the trial (T).

Order of fire: WT + (A,B,C,T) x 5

Observe: M.V. pressure, unburnt, debris,
* firing-interval.

12. Physical and chemical examination during climatic storage — H.S.L.

The 5A, 5B and 5C rounds removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite NQ.018 Lot ... and the 1 lb. Cordite NQ 050 Lot .... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12, 18,24,30,36,42 and 48 months are to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C. 1417

O.B. PROC. 33931, ITEM 14

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE NQ/S 134-040 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1a.	Gun Q.F. 25-pr. Mk.2 No....	P. & E.O.
1b.	Charge Super	P. & E.O.
2.	Nitrocellulose ,...	E.F.Mulwala
3.	Propellant under trial Cordite NQ/S 134-040 Lot ... Gross amount required 600 lb. for make-up in Australia; 600 lb. for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite NQ/S 134-040 Lot D.10286.No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-Determination Determine A.C.W. of Cordite NQ/S 134-040 Lot .... by proof against Lot D.10286 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of charges 112 charges Cordite NQ/S 134-040 Lot ... to be made up without igniters, decoppering alloy etc. at the A.C.W. and each inserted in a cambric bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite NQ/S 134-040 Lot .... (A) against Lot D.10286. (T) Order of fire: W.T. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, firing interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 2 charges of Cordite NQ/S 134-040 Lot... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten-inch difference" Density Microscopical examination Breaking radius ratio test	M.S.L.

Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D.
Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80°C. Accelerated Heating Trial

9. Climatic storage

(A) 35 charges Cordite NQ/S 134-040 Lot.... to be stored in cambric bags supported on bearers in open wooden cordite boxes and 50 lb. Cordite NQ/S 134-040 Lot ... to be stored in a wooden Cordite box at 80°F. without maintained humidity. M.S.L.

(B) As (A) but stored under I.S.A.(A) conditions.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage M.S.L.

After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up without the cambric bags into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost.
If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B and 2C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months, 1 lb. of Cordite NQ/S 134-040 Lot ... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage P. & E.O.

At each period fire at 80°F. the 5A, 5B and 5C rounds against the ballistic standard for the trial (T).

Order of fire: WT + (A,B,C,T) x 5

Observe: M.V.,Pressure, unburnt, debris,
* firing interval.

12. Physical and chemical examination during climatic storage — M.S.L.

The 2A, 2B and 2C rounds removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual Examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test

The 1 lb. Cordite NQ/S 134-040 Lot .... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months is to be examined for V.M. by
(a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.

* Tests marked * may be omitted if inconvenient to apply.

PROJECT E.C. 1417

O.B. PROC. 33931, ITEM 16

TRIAL NO.333

CLIMATIC-BALLISTIC TRIAL OF CORDITE NQF/P 128 MADE FROM MECHANICALLY-NITRATED B.W.C. (85% ALPHA CELLULOSE)
PROGRAMME

		Department Responsible
1.	Gun B.L. 6" Mk.23 No.4896	P. & E.O.
2.	Nitrocellulose	E.F.Mulwala
3.	Propellant under trial Cordite NQF/P 128 Lot ... Gross amount required 5100 lb. for make-up in Australia; 5100 lb. for despatch in bulk to U.K.	E.F.M.
4.	Ballistic standard for trial Cordite NQF/P 128 Lot RNP 1450. No. of rounds required 41 (including 5 for charge-determination).	P. & E.O.
5.	Charge-determination Determine A.C.W. of Cordite NQF/P 128 Lot .... by proof against Lot RNP 1450 in a Cordite Proof Gun.	P. & E.O.
6.	Make-up of Charges 112 charges Cordite NQF/P 128 Lot ... to be made up without igniters, decoppering alloy etc. at the A.C.W. each in its Service silk bag.	E.F.M.
7.	Firing at commencement of climatic storage Fire at 80°F. 5 rounds (at the A.C.W.) of Cordite NQF/P 128 Lot ... (A) against Lot RNP 1450 (T). Order of Fire: WT. + (AT) x 5 Observe: M.V., pressure, unburnt, debris, firing interval.	P. & E.O.
8.	Physical and chemical examination at commencement of climatic storage 2 charges of Cordite NQF/P 128 Lot... to be examined as follows:- Visual examination Measurement of cord Weight per 100 inches "Ten inch difference" Density Microscopical examination Breaking radius ratio test	M.S.L.

Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.
Chemical Analysis
Heat Test
* Water Extract Test (electrometric)
* Colour Test
* 80° Accelerated Heating Trial

9. Climatic Storage — M.S.L.

(A) 35 charges Cordite NQF/P 128 Lot .... to be stored in Service Silk bags supported on bearers in open wooden cordite boxes and 100 lb. Cordite NQF/P 128 Lot .... to be stored in a wooden Cordite Box at 80°F. without maintained humidity.

(B) As (A) but stored under I.S.A.(A) conditions.

(C) As (A) but stored at 120°F. without maintained humidity.

10. Removal from climatic storage — M.S.L.

After 6,12,24,36 and 48 months -

(i) 5A, 5B and 5C charges to be removed and made up with the silk bags used for storage into rounds for firing. (The charges are to be weighed before and after making up to ensure that no cordite has been accidentally lost. If the latter should occur, the loss is to be made-up from the cordite stored in bulk under the same conditions).

(ii) 2A, 2B and 2C charges are to be removed for physical and chemical examination.

After 1,2,3,4,5,6,9,12,18,24,30,36,42 and 48 months 1 lb. of Cordite NQF/P128 Lot ... is to be removed from that stored in bulk at each temperature for measurement of V.M.

11. Firings during climatic storage — P. & E.O.

At each period fire at 80°F. the 5A, 5B and 5C rounds against the ballistic standard for the trial (T).

Order of Fire: WT + (A,B,C,T) x 5

Observe: M.V., pressure, unburnt, debris,
* firing interval.

12. Physical and chemical Examination during climatic storage — M.S.L.

The 2A, 2B and 2C charges removed after 6,12,24,36 and 48 months are to be examined as follows:-

Visual examination
Measurement of cord
Weight per 100 inches
"Ten-inch difference"
Density
Microscopical Examination
Breaking radius ratio test
Calorimetric value
V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46
Chemical Analysis
Heat Test
⁂ Water Extract Test (electrometric)
⁂ Colour Test

The 1 lb. Cordite NQF/P 128 Lot .... removed after storage in bulk at each temperature for 1,2,3,4,5,6,9,12, 18,24,30,36,42 and 48 months is to be examined for V.M. by (a) Specification method
(b) Methods of A.R.D. Explosives Report No.214/46.

⁂ Tests marked ⁂ may be omitted if inconvenient to apply.

Appendix 5

Results of tests by M.S.L. Maribyrnong on B.W.C. Consignment No.202

Maximum caliper (mils)	48
Minimum caliper (mils)	39
Mean density (oz./sq.ft./10 mils)	0.58
Mullen Burst Test:	
Maximum of 12 dry sheets (lb./sq.in.)	160
Minimum of 12 dry sheets (lb./sq.in.)	94
Total ash (%)	0.5
Ash insoluble in boiling H_2SO_4 (%)	0.1
Matter soluble in cold ether (%)	0.03
Alpha-cellulose (%)	85.75 (observed by A.P.M. Ltd.)
Lignin	Conforms to H_2SO_4 test

Appendix 6

Results of examination of nitrocelluloses made from BWC Consignment No. 202

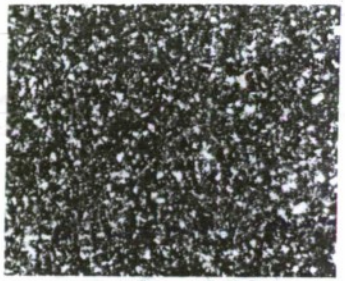
B.W.C. consignment no.	202								
Nitrocellulose lot no.	G3	G4	SP7	SP8	SP9/3A	SP9/3B	SP9/2	SP9/1	
Stabilisation scheme	(60 + 5 + 5 + PJ + 4 + 2 + 1 + 1	12 + 12 + 4 + 4 + PH + 4 + 4	40 + 5 + 5 + PJ + 4+2 + 1 + 1	12 + 12 + 4 + 4 + PJ	12+ 12 + 4 + 4 + 4 + PH	12 + 12 + 4 + 4 + 4 + 4 + PH	12 + 12 + 4 + 4 + PJ +4 + 4 + 4	12 + 12 + 4 + 4 + PJ + 4 + 4	
Alkali used	Na_2CO_3	Na_2CO_3	Na_2CO_3	Na_2CO_3	CaCO3 for 3rd & 4th boils. Na_2CO_3 for 5th boil.	$CaCO_3$ for 3rd & 4th boils. Na_2CO_3 for 5th & 6th boils.	$CaCO_3$	$CaCO_3$ for 3rd & 4th boils. Na_2CO_3 for 5th & 6th boils.	
Methyl Violet Paper Test.	30	30	30	30					mins.
B. & J. Test									
After 4th boil					1.55	1.55			mgm/N/gm
After Jordan pulping					Not Jordaned	Not Jordaned	1.6	1.6	"
After Jordan pulping and grit run.		1.95		0.99	do.	do.	1.45	1.45	"
After 5th boil		1.23		No 5th boil	1.09	1.09	1.24	No record	"
After 6th boil		1.02		No 6th boil	No 6th boil	0.96	No record	1.14	"
After 7th boil	0.97	No 7th boil	1.02	No 7th boil	No 7th boil	No 7th boil	1.07	No 7th boil	"
After Hollander pulping	No H.pulping	No H.pulping	No H.pulping	No H.pulping	0.92		No H.pulping	No H pulping	"
Heat Test	21	20	25	25					mins.
Nitrogen (Lunge)	13.12	13.14	12.19	12.29					%
Ash	0.20	0.34	0.23	0.39					%
Alkalinity	0.005	0.02	0.02	0.22					%$CaCO_3$
Ether-alcohol solubility	18.5	<15.2	99.6	99.5					%
Organic matter insol. in acetone	0.1	0.1	0.20	0.32					%
Viscosity	10	15	4	9					secs.
Settling Test	80	77	71	73	58	60	56		mls.
Sulphate	0.05	0.11	0.02	0.06					%H_2SO_4

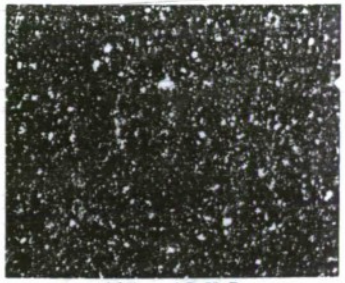
Appendix 7

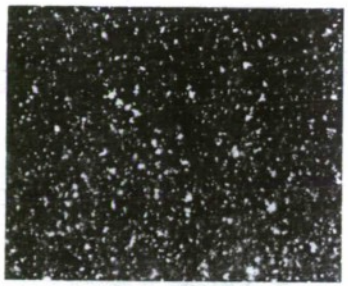
Data on Cordite SC.109 made from nitrocelluloses from BWC Consignment No.202

Mix No.	10E	11E	12E	Control 47 x 12	
Nitrocellulose lot no.	SP9/3A	SP9/3B	SP9/2	Test No.672	
Stabilisation scheme	12 + 12 + 4 + 4 + 4 + PH	12 + 12 + 4 + 4 + 4 + 4 + PH	12 + 12 + 4 + 4 + PJ + 4 + 4 + 4	Service	
		12 passes virgin paste			
Sheet: appearance	ca.1/16"specks all over	ca.1/16"specks all over	ca.1/16"specks all over	no specks	
Cord: die temperature	64	63	63	63	°C.
extrusion pressure	N.R.	600	540	600	lb/sq.in÷11.69
wt. per 100"	359	358	364	367	grs.
appearance	specky	only a few specks	slightly specky	no specks	
surface	rough	wavy	slightly rough	smooth	
		3 + 5 + 3 passes			
Sheet: appearance	very specky	specky	Somewhat specky	Slightly specky	
	(all were more specky than after 12 passes virgin paste)				
Cord: die temperature	65	64	65	65	°C.
extrusion pressure	800	650	730	700	lb/sq.in÷11.69
wt. per 100"	375	366	378	380	grs.
appearance					
surface					
		3 + 5 + 6 passes			
Sheet: appearance	very specky	slightly specky	slightly specky	slightly specky	
	(all except Mix 47 x 12 were less specky than after 3 + 5 + 3 passes)				
Cord: die temperature	66	63	65	64	°C.
extrusion pressure	620	600	570	650	lb/sq.in÷11.69
wt.per 100"	358	366	363	364	grs.
appearance	slightly specky	very few specks	very few specks	very few specks	
surface	slightly rough	smooth	smooth	smooth	
		3 + 5 + 9 passes			
Sheet: appearance	very specky	slightly specky	specky	slightly specky	
	(all variants were more specky than after 3 + 5 + 6 passes)				
Cord: die temperature	67	68	66	66	°C.
extrusion pressure					lb/sq.in÷11.69
wt. per 100"	358	364	372	368	grs.
appearance	specky	a few specks	very few specks	no specks	
surface	smooth	smooth	smooth	smooth	

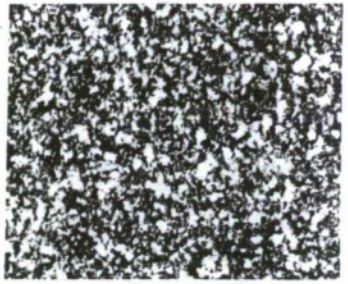
PHOTOGRAPHS OF CORDITE SC MILLED SHEET MADE FROM NITROCELLULOSES FROM BMC CONSIGNMENT NO.202
MAGNIFICATION - X1.


10E - 12 V.P.


11E - 12 V.P.


12E - 12 V.P.


47 x 12 - 12 V.P.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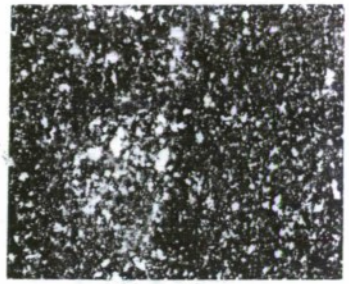
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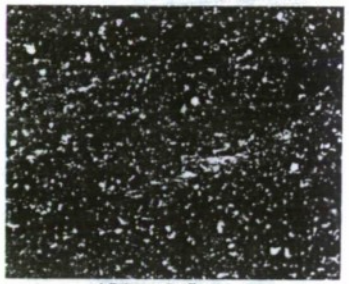
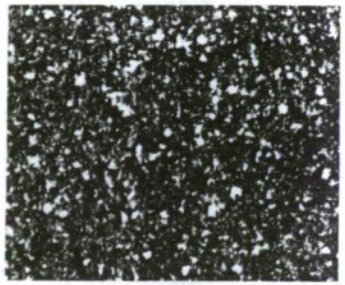
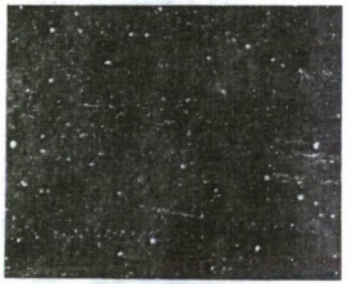
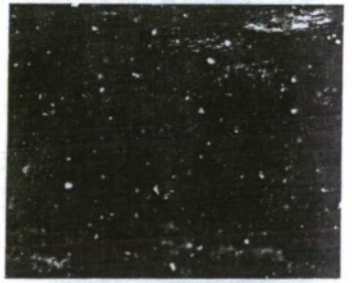

12E - 3-5-3.

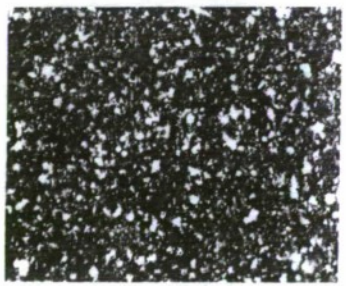

47 x 12 - 3-5-3.

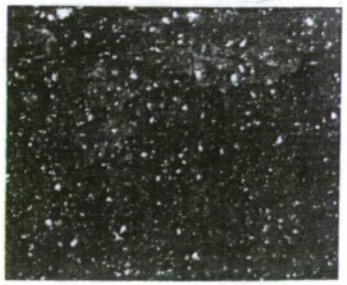

10E - 3-5-6.


11E - 3-5-6.


12E - 3-5-6.


47 x 12 - 3-5-6.





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Record Summary:

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Covering dates 1947 Oct.
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) CRDD 105/R/47
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